

INTERNATIONAL STANDARD

NORME INTERNATIONALE

**Electrical installations of buildings –
Part 5-52: Selection and erection of electrical equipment – Wiring systems**

**Installations électriques des bâtiments –
Partie 5-52: Choix et mise en œuvre des matériels électriques – Canalisations**

Withdawn



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WITNESS

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ELECTRICAL INSTALLATIONS OF BUILDINGS –**Part 5-52: Selection and erection of electrical equipment –
Wiring systems****FOREWORD**

- 1) The IEC (International Electrotechnical Commission) is a worldwide organization for standardization comprising all national electrotechnical committees (IEC National Committees). The object of the IEC is to promote international co-operation on all questions concerning standardization in the electrical and electronic fields. To this end and in addition to other activities, the IEC publishes International Standards. Their preparation is entrusted to technical committees; any IEC National Committee interested in the subject dealt with may participate in this preparatory work. International, governmental and non-governmental organizations liaising with the IEC also participate in this preparation. The IEC collaborates closely with the International Organization for Standardization (ISO) in accordance with conditions determined by agreement between the two organizations.
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International Standard IEC 60364-5-52 has been prepared by IEC technical committee 64: Electrical installations and protection against electric shock.

The IEC 60364 series (parts 1 to 6) is currently being restructured, without any technical changes, into a more simple form (see annex E).

According to a unanimous decision by the Committee of Action (CA/1720/RV (2000-03-21)), the restructured parts of IEC 60364 have not been submitted to National Committees for approval.

The text of this second edition of IEC 60364-5-52 is compiled from and replaces

- part 5-52, first edition (1993) and its amendment 1 (1997);
- part 5-523, second edition (1999).

This publication has been drafted, as close as possible, in accordance with the ISO/IEC Directives, Part 3.

Annex A forms an integral part of this standard.

Annexes B, C, D and E are for information only.

The committee has decided that the contents of this publication will remain unchanged until 2005. At this date, the publication will be

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

ELECTRICAL INSTALLATIONS OF BUILDINGS –

Part 5-52: Selection and erection of electrical equipment – Wiring systems

520 Introduction

520.1 Scope

Part 5-52 of IEC 60364 deals with the selection and erection of wiring systems.

NOTE This standard also applies in general to protective conductors, while IEC 60364-5-54 contains further requirements for those conductors.

520.2 Normative references

The following normative documents contain provisions which, through reference in this text, constitute provisions of this part of IEC 60364. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. However, parties to agreements based on this part of IEC 60364 are encouraged to investigate the possibility of applying the most recent editions of the normative documents indicated below. For undated references, the latest edition of the normative document referred to applies. Members of IEC and ISO maintain registers of currently valid International Standards.

IEC 60228: 1978, *Conductors of insulated cables*

IEC 60287-1-1:1994, *Electric cables – Calculation of the current rating – Part 1: Current rating equations (100 % load factor) and calculation of losses – Section 1: General*

IEC 60287-2-1:1994, *Electric cables – Calculation of the current rating – Part 2: Thermal resistance – Section 1: Calculation of thermal resistance*

IEC 60287-3-1:1995, *Electric cables – Calculation of the current rating – Part 3: Sections on operating conditions – Section 1: Reference operating conditions and selection of cable type*¹⁾

IEC 60332-1:1993, *Tests on electric cables under fire conditions – Part 1: Test on a single vertical insulated wire or cable*

IEC 60332-3-24:2000, *Tests on electric cables under fire conditions – Part 3-24: Test for vertical flame spread of vertically-mounted bunched wire or cables – Category C*

IEC 60439-2:2000, *Low-voltage switchgear and controlgear assemblies – Part 2: Particular requirements for busbar trunking systems (busways)*

IEC 60529:1989, *Degrees of protection provided by enclosures (IP Code)*²⁾

IEC 60614 (all parts), *Specification for conduits for electrical installations*

IEC 61200-52:1993, *Electrical installation guide – Part 52: Selection and erection of electrical equipment – Wiring systems*

ISO 834 (all parts) *Fire-resistance tests – Elements of building construction*

¹⁾ A consolidated edition 1.1 exists (1999) that includes IEC 60287-3-1 (1995) and its amendment 1 (1999).

²⁾ A consolidated edition 2.1 exists (2001) that includes IEC 60529 (1989) and its amendment 1 (1999).

520.3 General

Consideration shall be given to the application of the fundamental principles of IEC 60364-1 as it applies to cables and conductors, to their termination and/or jointing, to their associated supports or suspensions and their enclosures or methods of protection against external influences.

521 Types of wiring systems

521.1 The method of installation of a wiring system in relation to the type of conductor or cable used shall be in accordance with table 52-1, provided the external influences are covered by the requirements of the relevant product standards.

521.2 The method of installation of a wiring system in relation to the situation concerned shall be in accordance with table 52-2.

521.3 Examples of wiring systems together with reference to the appropriate table of current-carrying capacity are shown in table 52-3.

NOTE 1 Other types of wiring systems, not covered in this standard, may be used provided they comply with the general rules of this standard.

NOTE 2 Table 52-3 gives the reference method of installation where it is considered that the same current-carrying capacities can safely be used. It is not implied that all these items are necessarily recognized in national rules of all countries.

521.4 Busbar trunking systems

Busbar trunking systems shall comply with IEC 60439-2 and shall be installed in accordance with the manufacturer's instructions. The installation shall be in accordance with the requirements of clauses 522 (with the exception of 522.1.1, 522.3.3, 522.8.7, 522.8.8 and 522.8.9), 525, 526, 527 and 528.

521.5 AC circuits

Conductors of a.c. circuits installed in ferromagnetic enclosures shall be arranged so that all conductors of each circuit are contained in the same enclosure.

NOTE If this condition is not fulfilled, overheating and excessive voltage drop may occur due to inductive effects.

Table 52-1 (52F) – Selection of wiring systems

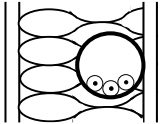
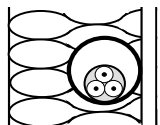
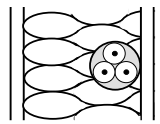
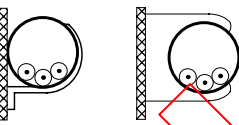
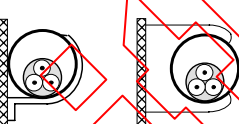
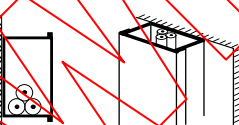
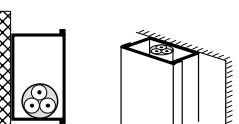
Conductors and cables		Method of installation							
		Without fixings	Clipped direct	Conduit	Cable trunking (including skirting trunking, flush floor trunking)	Cable ducting	Cable ladder Cable tray Cable brackets	On in- sulators	Support wire
Bare conductors		–	–	–	–	–	–	+	–
Insulated conductors		–	–	+	+	+	–	+	–
Sheathed cables (including armoured and mineral insulated)	Multi-core	+	+	+	+	+	+	0	+
	Single-core	0	+	+	+	+	+	0	+
+ Permitted. – Not permitted. 0 Not applicable, or not normally used in practice.									

Table 52-2 (52G) – Erection of wiring systems

Situations	Method of installation							
	Without fixings	With fixings	Conduit	Cable trunking (including skirting trunking, flush floor trunking)	Cable ducting	Cable ladder, cable tray, cable brackets	On insulators	Support wire
Building voids	40, 46, 15, 16	0	15, 16, 41, 42	–	43	30, 31, 32, 33, 34	–	–
Cable channel	56	56	54, 55	0	44, 45	30, 31, 32, 33, 34	–	–
Buried in ground	72, 73	0	70, 71	–	70, 71	0	–	–
Embedded in structure	57, 58	3	1, 2, 59, 60	50, 51, 52, 53	44, 45	0	–	–
Surface mounted	–	20, 21, 22, 23	4, 5	6, 7, 8, 9, 12, 13, 14	6, 7, 8, 9	30, 31, 32, 33, 34	36	–
Overhead	–	–	0	10, 11	–	30, 31, 32, 33, 34	36	35
Immersed	80	80	0	–	0	0	–	–
The number in each box indicates the item number in table 52-3. – Not permitted. 0 Not applicable or not normally used in practice.								

Table 52-3 (52H) – Examples of methods of installation providing instructions for obtaining current-carrying capacity

NOTE The illustrations are not intended to depict actual product or installation practices but are indicative of the method described.

Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity (see annex A)
1	 Room	Insulated conductors or single-core cables in conduit in a thermally insulated wall ^a	A1
2	 Room	Multi-core cables in conduit in a thermally insulated wall ^a	A2
3	 Room	Multi-core cable direct in a thermally insulated wall ^a	A1
4		Insulated conductors or single-core cables in conduit on a wooden, or masonry wall or spaced less than 0,3 × conduit diameter from it	B1
5		Multi-core cable in conduit on a wooden, or masonry wall or spaced less than 0,3 × conduit diameter from it	B2
6	 6	Insulated conductors or single-core cables in cable trunking on a wooden wall – run horizontally ^b – run vertically ^{b, c}	B1
7			
8	 8	Multi-core cable in cable trunking on a wooden wall – run horizontally ^b – run vertically ^{b, c}	Under consideration ^d
9			

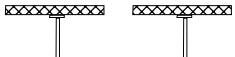
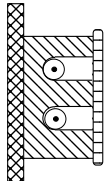
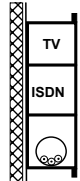
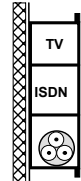
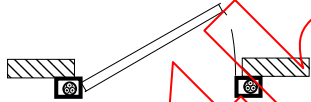
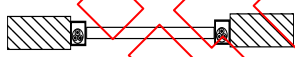
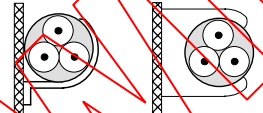
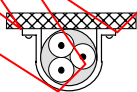
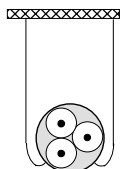
^a The inner skin of the wall has a thermal conductance of not less than 10 W/m² · K.

^b Values given for installation methods B1 and B2 in annex A are for a single circuit. Where there is more than one circuit in the trunking the group reduction factor given in table A.52-17 is applicable, irrespective of the presence of an internal barrier or partition.

^c Care shall be taken where the cable runs vertically and ventilation is restricted. The ambient temperature at the top of the vertical section can be increased considerably. The matter is under consideration.

^d Values for reference method B2 may be used.

Table 52-3 (continued)

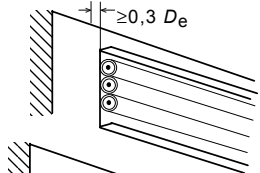
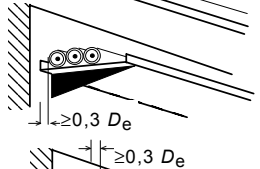
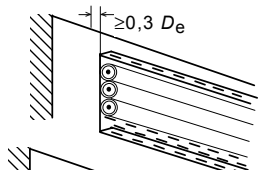
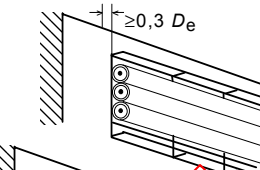
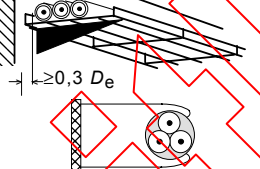
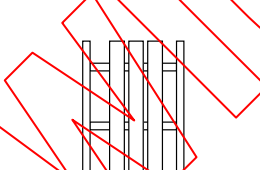
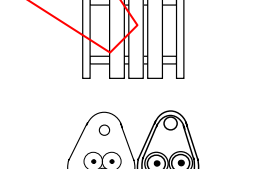
Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity (see annex A)
10		Insulated conductors or single-core cable in suspended cable trunking ^a	B1
11		Multi-core cable in suspended cable trunking ^a	B2
12		Insulated conductors or single-core cable run in mouldings ^b	A1
13		Insulated conductors or single-core cables in skirting trunking	B1
14		Multi-core cable in skirting trunking	B2
15		Insulated conductors in conduit or single-core or multi-core cable in architrave ^c	A1
16		Insulated conductors in conduit or single-core or multi-core cable in window frames ^c	A1
20		Single-core or multi-core cables: – fixed on, or spaced less than $0,3 \times$ cable diameter from a wooden wall	C
21		– fixed directly under a wooden ceiling	C, with item 3 of table A.52-17
22		– spaced from a ceiling	Under consideration

^a Values given for installation methods B1 and B2 in annex A are for a single circuit. Where there is more than one circuit in the trunking the group reduction factor given in table A.52-17 is applicable, irrespective of the presence of an internal barrier or partition.

^b The thermal resistivity of the enclosure is assumed to be poor because of the material of construction and possible air spaces. Where the construction is thermally equivalent to methods of installation 6 or 7, reference method B1 may be used.

^c The thermal resistivity of the enclosure is assumed to be poor because of the material of construction and possible air spaces. Where the construction is thermally equivalent to methods of installation 6, 7, 8, or 9, reference methods B1 or B2 may be used.

Table 52-3 (continued)

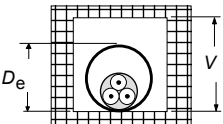
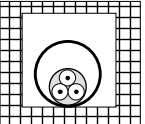
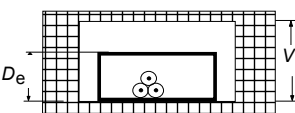
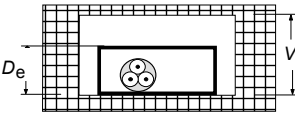
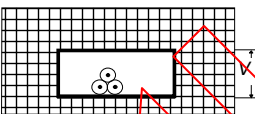
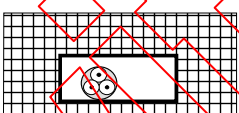
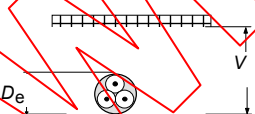
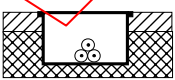
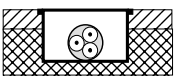
Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity (see annex A)
30		On unperforated tray ^c	C with item 2 of table A.52-17 ^a
31		On perforated tray ^c	E or F with item 4 of table A.52-17 ^{a, b}
32		On brackets or on a wire mesh ^c	E or F
33		Spaced more than 0,3 times cable diameter from a wall	E or F with item 4 or 5 of table A.52-17 or method G ^{a, b}
34		On ladder	E or F
35		Single-core or multi-core cable suspended from or incorporating a support wire	E or F
36		Bare or insulated conductors on insulators	G

^a For certain applications it may be more appropriate to use specific factors, for example tables A.52-20 and A.52-21 (see A.52.4.2 of annex A).

^b Care shall be taken where the cable runs vertically and ventilation is restricted. The ambient temperature at the top of the vertical section can be increased considerably. The matter is under consideration.

^c D_e = the external diameter of a multi-core cable:
 – 2,2 x the cable diameter when three single core cables are bound in trefoil, or
 – 3 x the cable diameter when three single core cables are laid in flat formation.

Table 52-3 (continued)

Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity (see annex A)
40		Single-core or multi-core cable in a building void ^{a, 2}	$1,5 D_e \leq V < 20 D_e$ B2 $V \geq 20 D_e$ B1
42		Single-core or multi-core cable in conduit in a building void ^d	Under consideration
24		Insulated conductors in cable ducting in a building void ^{a, c, d}	$1,5 D_e \leq V < 20 D_e$ B2 $V \geq 20 D_e$ B1
43		Single-core or multi-core cable in cable ducting in a building void ^d	Under consideration
44		Insulated conductors in cable ducting in masonry having a thermal resistivity not greater than $2 \text{ K} \cdot \text{m/W}$ ^{a, b, d}	$1,5 D_e \leq V < 5 D_e$ B2 $5 D_e \leq V < 50 D_e$ B1
45		Single-core or multi-core cable in cable ducting in masonry having a thermal resistivity not greater than $2 \text{ K} \cdot \text{m/W}$ ^d	Under consideration
46		Single-core or multi-core cable: – in a ceiling void – in a suspended floor ^{a, b}	$1,5 D_e \leq V < 5 D_e$ B2 $5 D_e \leq V < 50 D_e$ B1
50		Insulated conductors or single-core cable in flush cable trunking in the floor	B1
51		Multi-core cable in flush cable trunking in the floor	B2

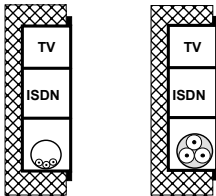
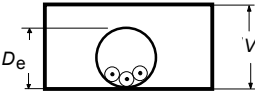
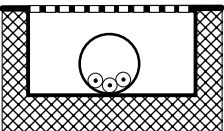
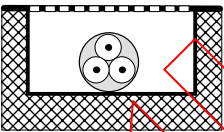
^a V = the smaller dimension or diameter of a masonry duct or void, or the vertical depth of a rectangular duct, floor or ceiling void.

^b D_e = the external diameter of a multi-core cable:
– $2,2 \times$ the cable diameter when three single core cables are bound in trefoil, or
– $3 \times$ the cable diameter when three single core cables are laid in flat formation.

^c D_e = external diameter of conduit or vertical depth of cable ducting.

^d Care shall be taken where the cable runs vertically and ventilation is restricted. The ambient temperature at the top of the vertical section can be increased considerably. The matter is under consideration.

Table 52-3 (continued)

Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity (see annex A)
52		Insulated conductors or single-core cables in embedded trunking	B1
53		Multi-core cable in embedded trunking	B2
54		Insulated conductors or single-core cables in conduit in an unventilated cable channel run horizontally or vertically ^{a, b}	$1,5 D_e \leq V < 20 D_e$ B2 $V \geq 20 D_e$ B1
55		Insulated conductors in conduit in an open or ventilated cable channel in the floor ^{c, d}	B1
56		Sheathed single-core or multi-core cable in an open or ventilated cable channel run horizontally or vertically ^d	B1
57		Single-core or multi-core cable direct in masonry having a thermal resistivity not greater than $2 \text{ K} \cdot \text{m/W}$ Without added mechanical protection ^{e, f}	C
58		Single-core or multi-core cable direct in masonry having a thermal resistivity not greater than $2 \text{ K} \cdot \text{m/W}$ With added mechanical protection ^{e, f}	C

^a D_e = external diameter of conduit
 V = internal depth of the channel
The depth of the channel is more important than the width.

^b Care shall be taken where the cable runs vertically and ventilation is restricted. The ambient temperature at the top of the vertical section can be increased considerably. The matter is under consideration.

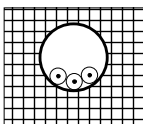
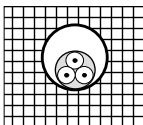
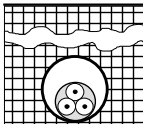
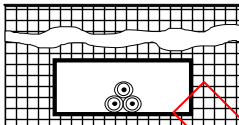
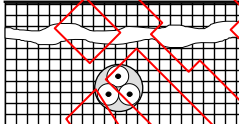
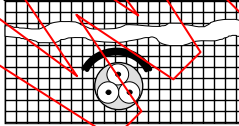
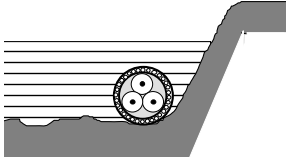
^c For multi-core cable installed in method 55, use ratings for reference method B2.

^d It is recommended that these methods of installation are used only in areas where access is restricted to authorised persons so that the reduction in current carrying capacity and the fire hazard due to the accumulation of debris can be prevented.

^e For cables having conductors not greater than 16 mm^2 , the current-carrying capacity may be higher.

^f Thermal resistivity of masonry is not greater than $2 \text{ K} \cdot \text{m/W}$.

Table 52-3 (continued)

Item No.	Methods of installation	Description	Reference method of installation to be used to obtain current-carrying capacity (see annex A)
59		Insulated conductors or single-core Cables in conduit in masonry ^a	B1
60		Multi-core cables in conduit in masonry ^a	B2
70		Multi-core cable in conduit or in cable ducting in the ground	D
71		Single-core cable in conduit or in cable ducting in the ground	D
72		Sheathed single-core or multi-core cables direct in the ground – without added mechanical protection (see note)	D
73		Sheathed single-core or multi-core cables direct in the ground – with added mechanical protection (see note)	D
80		Sheathed single-core or multi-core cables immersed in water	Under consideration

NOTE The inclusion of directly buried cables in this item is satisfactory when the soil thermal resistivity is of the order of 2,5 K·m/W. For lower soil resistivities, the current-carrying capacity for directly buried cables is appreciably higher than for cables in ducts.

^a Thermal resistivity of masonry is not greater than 2 K·m/W.

521.6 Conduits and trunking systems

Several circuits are allowed in the same conduit or trunking provided all conductors are insulated for the highest nominal voltage present.

522 Selection and erection of wiring systems in relation to external influences

NOTE The external influences categorized in table 51A of IEC 60364-5-51 which are of significance to wiring systems are included in this clause.

522.1 Ambient temperature (AA)

522.1.1 Wiring systems shall be selected and erected so as to be suitable for the highest local ambient temperature and to ensure that the limiting temperature indicated in table 54-4 will not be exceeded.

522.1.2 Wiring system components including cables and wiring accessories shall only be installed or handled at temperatures within the limits stated in the relevant product specification or as given by the manufacturers.

522.2 External heat sources

522.2.1 In order to avoid the effects of heat from external sources, one of the following methods or an equally effective method shall be used to protect wiring systems:

- shielding;
- placing sufficiently far from the source of heat;
- selecting a system with due regard for the additional temperature rise which may occur;
- local reinforcement or substitution of insulating material.

NOTE Heat from external sources may be radiated, convected or conducted, e.g.

- from hot water systems,
- from plant appliances and luminaires,
- from manufacturing process,
- through heat conducting materials,
- from solar gain of the wiring system or its surrounding medium.

522.3 Presence of water (AD)

522.3.1 Wiring systems shall be selected and erected so that no damage is caused by the ingress of water. The completed wiring system shall comply with the IP degree of protection relevant to the particular location.

NOTE In general, the sheaths and insulation of cables for fixed installations may be regarded, when intact, as proof against penetration by moisture. Special considerations apply to cables liable to frequent splashing, immersion or submersion.

522.3.2 Where water may collect or condensation may form in wiring systems, provision shall be made for its escape.

522.3.3 Where wiring systems may be subjected to waves (AD6), protection against mechanical damage shall be afforded by one or more of the methods of 522.6, 522.7 and 522.8.

522.4 Presence of solid foreign bodies (AE)

522.4.1 Wiring systems shall be selected and erected so as to minimize the danger arising from the ingress of solid foreign bodies. The completed wiring system shall comply with the IP degree of protection relevant to the particular location.

522.4.2 In a location where dust in significant quantity is present (AE4), additional precautions shall be taken to prevent the accumulation of dust or other substances in quantities which could adversely affect the heat dissipation from the wiring system.

NOTE A wiring system which facilitates the removal of dust may be necessary (see clause 529).

522.5 Presence of corrosive or polluting substances (AF)

522.5.1 Where the presence of corrosive or polluting substances, including water, is likely to give rise to corrosion or deterioration, parts of the wiring system likely to be affected shall be suitably protected or manufactured from a material resistant to such substances.

NOTE Suitable protection for application during erection may include protective tapes, paints or grease.

522.5.2 Dissimilar metals liable to initiate electrolytic action shall not be placed in contact with each other, unless special arrangements are made to avoid the consequences of such contacts.

522.5.3 Materials liable to cause mutual or individual deterioration or hazardous degradation shall not be placed in contact with each other.

522.6 Impact (AG)

522.6.1 Wiring systems shall be selected and erected so as to minimize the damage arising from mechanical stress, e.g. by impact, penetration or compression.

522.6.2 In fixed installations where impacts of medium severity (AG2) or high severity (AG3) can occur protection shall be afforded by:

- the mechanical characteristics of the wiring system; or
- the location selected; or
- the provision of additional local or general mechanical protection; or
- by any combination of the above.

522.7 Vibration (AH)

522.7.1 Wiring systems supported by or fixed to structures of equipment subject to vibration of medium severity (AH2) or high severity (AH3) shall be suitable for such conditions, particularly where cables and cable connections are concerned.

NOTE Special attention should be paid to connections to vibrating equipment. Local measures may be adopted such as flexible wiring systems.

522.7.2 Fixed installation of suspended current-using equipment, e.g. luminaires, shall be connected by cable with flexible core. Where no vibration nor movement can be expected, cable with non-flexible core may be used

522.8 Other mechanical stresses (AJ)

522.8.1 Wiring systems shall be selected and erected so as to prevent during installation, use or maintenance, damage to the sheath and insulation of cables and insulated conductors and their terminations.

522.8.2 (522.8.1.1) When buried in the structure, conduits or cable ducting systems shall be completely erected for each circuit before any insulated conductor or cable is drawn in.

522.8.3 (522.8.1.2) The radius of every bend in a wiring system shall be such that conductors or cables shall not suffer damage.

522.8.4 (522.8.1.3) Where the conductors or cables are not supported continuously due to the method of the installation, they shall be supported by suitable means at appropriate intervals in such a manner that the conductors or cables do not suffer damage by their own weight.

522.8.5 (522.8.1.4) Where a permanent tensile stress is applied to the wiring system (e.g. by its own weight in vertical runs) a suitable type of cable or conductor with appropriate cross-sectional areas and method of mounting shall be selected in such a manner that the conductors or cables do not suffer damage by their own weight.

522.8.6 (522.8.1.5) Wiring systems intended for the drawing in or out of conductors or cables shall have adequate means of access to allow this operation.

522.8.7 (522.8.1.6) Wiring systems buried in floors shall be sufficiently protected to prevent damage caused by the intended use of the floor.

522.8.8 (522.8.1.7) Wiring systems which are rigidly fixed and buried in the walls shall be run horizontally or vertically or parallel to the room edges.

Wiring systems concealed in the structure but not fixed may follow the shortest practical route.

522.8.9 (522.8.1.8) Flexible wiring systems shall be installed so that excessive tensile stress to the conductors and connections is avoided.

522.9 Presence of flora and/or mould growth (AK)

522.9.1 Where the conditions experienced or expected constitute a hazard (AK2), the wiring system shall be selected accordingly or special protective measures shall be adopted.

NOTE An installation method which facilitates the removal of such growths may be necessary (see clause 529).

522.10 Presence of fauna (AL)

522.10.1 Where conditions experienced or expected constitute a hazard (AL2) the wiring system shall be selected accordingly or special protective measures shall be adopted, for example, by:

- the mechanical characteristics of the wiring system; or
- the location selected; or
- the provision of additional local or general mechanical protection; or
- by any combination of the above.

522.11 Solar radiation (AN)

522.11.1 Where significant solar radiation (AN2) is experienced or expected, a wiring system suitable for the conditions shall be selected and erected or adequate shielding shall be provided.

NOTE See also 522.2.1 dealing with temperature rise.

522.12 Seismic effects (AP)

522.12.1 The wiring system shall be selected and erected with due regard to the seismic hazards of the location of the installation.

522.12.2 Where the seismic hazards experienced are low severity (AP2) or higher, particular attention shall be paid to the following:

- the fixing of wiring systems to the building structure;
- the connections between the fixed wiring and all items of essential equipment, e.g. safety services, shall be selected for their flexible quality.

522.13 Wind (AR)

522.13.1 See 522.7, Vibration (AH), and 522.8, Other mechanical stresses (AJ).

522.14 Nature of processed or stored materials (BE)

522.14.1 See 527, Selection and erection of wiring systems to minimize the spread of fire.

522.15 (522.14) Building design (CB)

522.15.1 (522.14.1) Where risks due to structural movement exist (CB3), the cable support and protection system employed shall be capable of permitting relative movement so that conductors and cables are not subjected to excessive mechanical stress.

522.15.2 (522.14.2) For flexible or unstable structures (CB4), flexible wiring systems shall be used.

523 Current-carrying capacities

523.1 (523.1.3) The current to be carried by any conductor for sustained periods during normal operation shall be such that the appropriate temperature limit specified in table 52-4 is not exceeded. The value of current shall be selected in accordance with 523.2, or determined in accordance with 523.3.

Table 52-4 (52-A) – Maximum operating temperatures for types of insulation

Type of insulation	Temperature limit ^a °C
Polyvinyl-chloride (PVC)	70 at the conductor
Cross-linked polyethylene (XLPE) and ethylene propylene rubber (EPR)	90 at the conductor ^b
Mineral (PVC covered or bare exposed to touch)	70 at the sheath
Mineral (bare not exposed to touch and not in contact with combustible material)	105 at the sheath ^{b, c}
^a The maximum permissible conductor temperatures given in table 52-4 on which the tabulated current-carrying capacities given in annex A are based, have been taken from IEC 60502 (1983) and IEC 60702 (1981) ^a and are shown on these tables. ^b Where a conductor operates at a temperature exceeding 70 °C it shall be ascertained that the equipment connected to the conductor is suitable for the resulting temperature at the connection. ^c For mineral insulated cables, higher operating temperatures may be permissible dependent upon the temperature rating of the cable, its terminations, the environmental conditions and other external influences.	

523.2 (523.1.4) The requirement of 523.1 is considered to be satisfied if the current for insulated conductors and cables without armour does not exceed the appropriate values selected from the tables in annex A with reference to table 52-3, subject to any necessary correction factors given in annex A.

NOTE 1 It is recognized that National Committees may wish to adapt the tables of annex A to a simplified form for their national rules. An example of one acceptable method of simplification is given in annex B.

NOTE 2 Simplified tables are under consideration which are intended to be suitable for day-to-day use in smaller installations and to be suitable for selection of cable sizes in relation to circuit design current and type and nominal current of the overcurrent protective device.

523.3 (523.1.5) The appropriate value of current-carrying capacities may also be determined as described in IEC 60287, or by test, or by calculation using a recognized method, provided that the method is stated. Where appropriate, account shall be taken of the characteristics of the load and, for buried cables, the effective thermal resistance of the soil.

523.4 (523.2.1) The ambient temperature is the temperature of the surrounding medium when the cable(s) or insulated conductor(s) under consideration are not loaded.

523.5 (523.4) Groups containing more than one circuit

The group reduction factors are applicable to groups of insulated conductors or cables having the same maximum operating temperature.

For groups containing cables or insulated conductors having different maximum operating temperatures, the current-carrying capacity of all the cables or insulated conductors in the group shall be based on the lowest maximum operating temperature of any cable in the group together with the appropriate group reduction factor.

If, due to known operating conditions, a cable or insulated conductor is expected to carry a current not greater than 30 % of its grouped rating, it may be ignored for the purpose of obtaining the reduction factor for the rest of the group.

523.6 (523.5) Number of loaded conductors

523.6.1 (523.5.1) The number of conductors to be considered in a circuit are those carrying load current. Where it can be assumed that conductors in polyphase circuits carry balanced currents, the associated neutral conductor need not be taken into consideration. Under these conditions a four-core cable is given the same capacity as a three-core cable having the same conductor cross-sectional area for each phase conductor. Four and five core cables may have higher current-carrying capacities when only three conductors are loaded.

523.6.2 (523.5.2) Where the neutral conductor in a multi-core cable carries current as a result of an unbalance in the phase currents the temperature rise due to the neutral current is offset by the reduction in the heat generated by one or more of the phase conductors. In this case the conductor size shall be chosen on the basis of the highest phase current.

In all cases the neutral conductor shall have a cross-sectional area adequate to afford compliance with 523.1.

523.6.3 (523.5.3) Where the neutral conductor carries current without corresponding reduction in load of the phase conductors, the neutral conductor shall be taken into account in ascertaining the rating of the circuit. Such currents may be caused by a significant harmonic current in three-phase circuits. If the harmonic content is greater than 10 % the neutral conductor shall not be smaller than the phase conductors. Thermal affects due to the presence of harmonic currents and the corresponding reduction factors for higher harmonic currents are given in annex D.

523.6.4 (523.5.4) Conductors which serve the purpose of protective conductors only (PE conductors) are not to be taken into consideration. PEN conductors shall be taken into consideration in the same way as neutral conductors.

523.7 (523.6) Conductors in parallel

Where two or more conductors are connected in parallel in the same phase or pole of the system, either:

a) measures shall be taken to achieve equal load current sharing between them;

This requirement is considered to be fulfilled if the conductors are of the same material, have the same cross-sectional area, are approximately the same length and have no branch circuits along the length, and

- either the conductors in parallel are multi-core cables or twisted single-core cables or insulated conductors, or
- the conductors in parallel are non-twisted single-core cables or insulated conductors in trefoil or flat formation and have a cross-sectional area less than or equal to 50 mm² in copper or 70 mm² in aluminium;
- or (if the conductors in parallel are non-twisted single-core cables or insulated conductors in trefoil or in flat formation and have cross-sectional areas greater than 50 mm² in copper or 70 mm² in aluminium) the special configuration necessary for such formations are adopted. These configurations consist of suitable groupings and spacings of the different phases or poles. (This subject is under consideration.)

or

b) special consideration shall be given to the load current sharing to meet the requirements of 523.1.

523.8 (523.7) Variation of installation conditions along a route

Where the heat dissipation differs in one part of a route to another, the current-carrying capacity shall be determined so as to be appropriate for the part of the route having the most adverse conditions.

524 Cross-sectional areas of conductors

524.1 The cross-sectional area of line conductors in a.c. circuits and of live conductors in d.c. circuits shall be not less than the values given in table 52-5.

NOTE This is for mechanical reasons.

524.2 The neutral conductor, if any, shall have the same cross-sectional area as the line conductor:

- in single-phase, two-wire circuits whatever the section;
- in polyphase and single-phase three-wire circuits, when the size of the line conductors is less than or equal to 16 mm² in copper, or 25 mm² in aluminium.

524.3 For polyphase circuits where each phase conductor has a cross-sectional area greater than 16 mm² in copper or 25 mm² in aluminium, the neutral conductor may have a smaller cross-sectional area than that of the line conductors if the following conditions are simultaneously fulfilled:

- the expected maximum current including harmonics, if any, in the neutral conductor during normal service is not greater than the current-carrying capacity of the reduced cross-sectional area of the neutral conductor;

NOTE The load carried by the circuit under normal service conditions should be practically equally distributed between the phases.

- the neutral conductor is protected against overcurrents according to the rules of 431.2 of IEC 60364-4-43;
- the size of the neutral conductor is at least equal to 16 mm² in copper or 25 mm² in aluminium.

Table 52-5 (52J) – Minimum cross-sectional area of conductors

Types of wiring system		Use of the circuit	Conductor	
			Material	Cross-sectional area mm ²
Fixed Installations	Cables and Insulated conductors	Power and lighting circuits	Copper Aluminium	1,5 2,5 (see note 1)
		Signalling and control circuits	Copper	0,5 (see note 2)
	Bare conductors	Power circuits	Copper Aluminium	10 16
		Signalling and control circuits	Copper	4
Flexible connections with insulated conductors and cables		For a specific appliance	Copper	As specified in the relevant IEC publication
		For any other application		0,75 ^a
		Extra low voltage circuits for special applications		0,75
NOTE 1 Connectors used to terminate aluminium conductors shall be tested and approved for this specific use.				
NOTE 2 In signalling and control circuits intended for electronic equipment a minimum cross-sectional area of 0,1 mm ² is permitted.				
^{a)} In multi-core flexible cables containing seven or more cores, note 2 applies.				

525 Voltage drop in consumers' installations

Under consideration.

NOTE In the absence of other considerations, it is recommended that in practice the voltage drop between the origin of consumer's installation and the equipment should not be greater than 4 % of the nominal voltage of the installation.

Other considerations include start-up time for motors and equipment with high inrush current.

Temporary conditions such as voltage transients and voltage variation due to abnormal operation may be disregarded.

526 Electrical connections

526.1 Connections between conductors and between conductors and other equipment shall provide durable electrical continuity and adequate mechanical strength and protection.

NOTE See IEC 61200-52.

526.2 The selection of the means of connection shall take account, as appropriate, of

- the material of the conductor and its insulation;
- the number and shape of the wires forming the conductor;
- the cross-sectional area of the conductor; and
- the number of conductors to be connected together.

NOTE The use of soldered connections should be avoided in power wiring. If used, the connections should be designed to take account of creep and mechanical stresses (see 522.6, 522.7 and 522.8).

526.3 All connections shall be accessible for inspection, testing and maintenance, except for the following:

- joints in buried cables;
- compound-filled or encapsulated joints;
- connections between a cold tail and the heating element as in ceiling heating, floor heating and trace heating systems.

526.4 Where necessary, precautions shall be taken so that the temperature attained by connections in normal service shall not impair the effectiveness of the insulation of conductors connected to them or supporting them.

527 Selection and erection of wiring systems to minimize the spread of fire

527.1 Precautions within a fire-segregated compartment

527.1.1 The risk of spread of fire shall be minimized by the selection of appropriate materials and erection in accordance with clause 522.

527.1.2 Wiring systems shall be installed so that the general building structural performance and fire safety are not reduced.

527.1.3 Cables complying with, at least, the requirements of IEC 60332-1 and products having the necessary fire resistance specified in IEC 60614 and in other IEC standards for wiring systems may be installed without special precautions.

NOTE In installations where particular risk is identified, cables complying with the more onerous tests for bunched cables described in IEC 60332-3-24 may be necessary.

527.1.4 Cables not complying, as a minimum, with the flame propagation requirements of IEC 60332-1 shall, if used, be limited to short lengths for connection of appliances to permanent wiring systems and shall, in any event, not pass from one fire-segregated compartment to another.

527.1.5 Parts of wiring systems other than cables which do not comply, as a minimum, with the flame propagation requirements of IEC 60614 and other IEC standards for wiring systems but which comply in all other respects with the requirements of IEC 60614 and other IEC standards for wiring systems shall, if used, be completely enclosed in suitable non-combustible building materials.

NOTE The "other standards" referred to in 527.1.3 and 527.1.5 are under consideration.

527.2 Sealing of wiring system penetrations

527.2.1 Where a wiring system passes through elements of building construction such as floors, walls, roofs, ceilings, partitions or cavity barriers, the openings remaining after passage of the wiring system shall be sealed according to the degree of fire resistance (if any) prescribed for the respective element of building construction before penetration (see ISO 834).

NOTE 1 (527.4.1) During erection of a wiring system temporary sealing arrangements may be required.

NOTE 2 (527.4.2) During alteration work, sealing should be reinstated as quickly as possible.

527.2.2 Wiring systems such as conduits, cable ducting, cable trunking, busbars or busbar trunking systems which penetrate elements of building construction having specified fire resistance shall be internally sealed to the degree of fire resistance of the respective element before penetration as well as being externally sealed as required by 527.2.1.

527.2.3 Subclauses 527.2.1 and 527.2.2 are satisfied if the sealing of the wiring system concerned has been type tested.

527.2.4 Conduit and trunking systems of material complying with the flame propagation test of IEC 60614 and having a maximum internal cross-section area of 710 mm² need not be internally sealed provided that

- the system satisfies the test of IEC 60529 for IP33; and
- any termination of the system in one of the compartments, separated by the building construction being penetrated, satisfies the test of IEC 60529 for IP33.

527.2.5 No wiring system shall penetrate an element of building construction which is intended to be load bearing unless the integrity of the load bearing element can be assured after such penetration (see ISO 834).

NOTE This subclause should be transferred to clause 61 of IEC 60364-6-61 in case of an updating of this clause.

527.2.6 All sealing arrangements used in accordance with 527.2.1 and 527.2.3 shall comply with the following requirements and those of 527.2.7 (527.3).

NOTE 1 These requirements may be transferred to an IEC product standard, if such a standard is prepared.

- They should be compatible with the materials of the wiring system with which they are in contact.
- They should permit thermal movement of the wiring system without reduction of the sealing quality.
- They should be of adequate mechanical stability to withstand the stresses which may arise through damage to the support of the wiring system due to fire.

NOTE 2 This subclause may be satisfied if:

- either cable clamps or cable supports are installed within 750 mm of the seal, and are able to withstand the mechanical loads expected following the collapse of the supports on the fire side of the seal to the extent that no strain is transferred to the seal; or
- the design of the sealing system itself provides adequate support.

527.2.7 (527.3.1) Sealing arrangements intended to satisfy 527.2.1 or 527.2.2 above shall resist external influences to the same degree as the wiring system with which they are used and in addition they shall meet all of the following requirements:

- they shall be resistant to the products of combustion to the same extent as the elements of building construction which have been penetrated;
- they shall provide the same degree of protection from water penetration as that required for the building construction element in which they have been installed;
- the seal and the wiring system shall be protected from dripping water which may travel along the wiring system or which may otherwise collect around the seal unless the materials used in the seal are all resistant to moisture when finally assembled for use.

527.2.8 (527.5.1) The sealing arrangements shall be inspected to verify that they conform to the erection instructions associated with the IEC type test for the product concerned (under consideration in ISO). No further test is required following such verification.

528 Proximity of wiring systems to other services

528.1 Proximity to electrical services

Band I and band II voltage circuits shall not be contained in the same wiring system unless every cable is insulated for the highest voltage present or one of the following methods is adopted:

- each conductor of a multicore cable is insulated for the highest voltage present in the cable; or

- the cables are insulated for their system voltage and installed in a separate compartment of a cable ducting or cable trunking system; or
- a separate conduit system is employed.

NOTE Special considerations of electrical interference, both electromagnetic and electrostatic, may apply to telecommunications circuits, data transfer circuits and the like.

528.2 Proximity to non-electrical services

528.2.1 Wiring systems shall not be installed in the vicinity of services which produce heat, smoke or fumes likely to be detrimental to the wiring, unless it is protected from harmful effects by shielding arranged so as not to affect the dissipation of heat from the wiring.

528.2.2 Where a wiring system is routed below services liable to cause condensation (such as water, steam or gas services), precautions shall be taken to protect the wiring system from deleterious effects.

528.2.3 Where electrical services are to be installed in proximity to non-electrical services they shall be so arranged that any foreseeable operation carried out on the other services will not cause damage to the electrical services or the converse.

NOTE This may be achieved by:

- suitable spacing between the services; or
- the use of mechanical or thermal shielding.

528.2.4 Where an electrical service is located in close proximity to non-electrical services, both the following conditions shall be met:

- wiring systems shall be suitably protected against the hazards likely to arise from the presence of the other services in normal use; and
- protection against indirect contact shall be afforded in accordance with the requirements of clause 413 of IEC 60364-4-41, non-electrical metallic services being considered as extraneous conductive parts.

529 Selection and erection of wiring systems in relation to maintainability, including cleaning

529.1 The knowledge and experience of the person or persons likely to carry out the maintenance shall be taken into account in the selection and erection of the wiring system.

529.2 Where it is necessary to remove any protective measure in order to carry out maintenance, provision shall be made so that the protective measure can be reinstated without reduction of the degree of protection originally intended.

529.3 Provision shall be made for safe and adequate access to all parts of the wiring system which may require maintenance.

NOTE In some situations, it may be necessary to provide permanent means of access by ladders, walkways, etc.

Annex A (normative)

Current-carrying capacities

A.52.1 Introduction (523.1.1 Scope, in part)

The requirements of this annex are intended to provide for a satisfactory life of conductor and insulation subjected to the thermal effects of carrying current for prolonged periods of time in normal service. Other considerations affect the choice of cross-sectional area of conductors, such as the requirements for protection against electric shock (IEC 60364-4-41), protection against thermal effects (IEC 60364-4-42), overcurrent protection (IEC 60364-4-43), voltage drop (clause 525 of this standard), and limiting temperatures for terminals of equipment to which the conductors are connected (clause 526 of this standard).

For the time being, this annex relates only to non-armoured cables and insulated conductors having a nominal voltage not exceeding 1 kV a.c. or 1,5 kV d.c. This annex does not apply to armoured single-core cables.

NOTE If armoured single-core cables are used, an appreciable reduction of the current-carrying capacities given in this annex may be required. The cable supplier should be consulted. This is also applicable to non-armoured single-core cables in single way metallic ducts (see 521.5).

(523.1.4 NOTE 3, in part)

The values in tables A.52-2 to A.52-13 apply to cables without armour and have been derived in accordance with the methods given in IEC 60287 using such dimensions as specified in IEC 60502 and conductor resistances given in IEC 60228. Known practical variations in cable construction (e.g. form of conductor) and manufacturing tolerances result in a spread of possible dimensions and hence current-carrying capacities for each conductor size. Tabulated current-carrying capacities have been selected so as to take account of this spread of values with safety and to lie on a smooth curve when plotted against conductor cross-sectional area.

(523.1.4 NOTE 4, in part)

For multi-core cables having conductors with a cross-sectional area of 25 mm² or larger, either circular or shaped conductors are permissible. Tabulated values have been derived from dimensions appropriate to shaped conductors.

A.52.2 (523.2) Ambient temperature

A.52.2.1 (523.2.2) The current-carrying capacities tabulated in this annex assume the following reference ambient temperatures:

- for insulated conductors and cables in air, irrespective of the method of installation: 30 °C;
- for buried cables, either directly in the soil or in ducts in the ground: 20 °C.

A.52.2.2 (523.2.3) Where the ambient temperature in the intended location of the insulated conductors or cables differs from the reference ambient temperature, the appropriate correction factor given in tables A.52-14 and A.52-15 shall be applied to the values of current-carrying capacity set out in tables A.52-2 to A.52-13. For buried cables, correction is not needed if the soil temperature exceeds 25 °C for only a few weeks a year.

NOTE For cables and insulated conductors in air, where the ambient temperature occasionally exceeds the reference ambient temperature, the possible use of the tabulated current-carrying capacities without correction is under consideration.

A.52.2.3 (523.2.4) The correction factors in tables A.52-14 and A.52-15 do not take account of the increase, if any, due to solar or other infra-red radiation. Where the cables or insulated conductors are subject to such radiation, the current-carrying capacity shall be derived by the methods specified in IEC 60287.

A.52.3 (523.3) Soil thermal resistivity

The current-carrying capacities tabulated in this annex for cables in the ground relate to a soil thermal resistivity of $2,5 \text{ K} \cdot \text{m/W}$. This value is considered necessary as a precaution for worldwide use when the soil type and geographical location are not specified (see IEC 60287-3-1).

In locations where the effective soil thermal resistivity is higher than $2,5 \text{ K} \cdot \text{m/W}$, an appropriate reduction in current-carrying capacity shall be made or the soil immediately around the cables shall be replaced by a more suitable material. Such cases can usually be recognized by very dry ground conditions. Correction factors for soil thermal resistivities other than $2,5 \text{ K} \cdot \text{m/W}$ are given in table A.52-15.

NOTE The current-carrying capacities tabulated in this annex for cables in the ground are intended to relate only to runs in and around buildings. For other installations, where investigations establish more accurate values of soil thermal resistivity appropriate for the load to be carried, the values of current-carrying capacity may be derived by the methods of calculation given in IEC 60287 or obtained from the cable manufacturer.

A.52.4 (523.4) Groups of insulated conductors or cables

A.52.4.1 (523.4.1) Installation types A to D in table A.52-1

The current-carrying capacities given in tables A.52-2 to A.52-7 relate to single circuits consisting of the following numbers of conductors:

- two insulated conductors or two single-core cables, or one twin-core cable;
- three insulated conductors or three single-core cables, or one three-core cable.

Where more insulated conductors or cables are installed in the same group, the group reduction factors specified in tables A.52-17 to A.52-19 shall be applied.

NOTE The group reduction factors have been calculated on the basis of prolonged steady-state operation at a 100 % load factor for all live conductors. Where the loading is less than 100 % as a result of the conditions of operation of the installation, the group reduction factors may be higher.

A.52.4.2 (523.4.2) Installation types E and F in table A.52-1

The current-carrying capacities of tables A.52-8 to A.52-13 relate to the reference methods of installation.

For installations on trays, cleats and the like, current-carrying capacities for both single circuits and groups shall be obtained by multiplying the capacities given for the relevant arrangements of insulated conductors or cables in free air, as indicated in tables A.52-8 to A.52-13, by the installation and group reduction factors given in tables A.52-20 and A.52-21.

The following notes concern A.52.4.1 and A.52.4.2:

NOTE 1 Group reduction factors have been calculated as averages for the range of conductor sizes, cable types and installation conditions considered. Attention is drawn to the notes under each table. In some instances, a more precise calculation may be desirable.

NOTE 2 Group reduction factors have been calculated on the basis that the group consists of similar equally loaded insulated conductors or cables. When a group contains various sizes of cable or insulated conductor caution should be exercised over the current loading of the smaller ones (see A.52.5).

A.52.5 (523.4.3) Groups containing different sizes

Tabulated group reduction factors are applicable to groups consisting of similar equally loaded cables. The calculation of reduction factors for groups containing different sizes of equally loaded insulated conductors or cables is dependent on the total number in the group and the mix of sizes. Such factors cannot be tabulated but must be calculated for each group. The method of calculation of such factors is outside the scope of this standard. Some specific examples of where such calculations may be advisable are given below.

NOTE A group containing sizes of conductor spanning a range of more than three adjacent standard sizes may be considered as a group containing different sizes. A group of similar cables is taken to be a group where the current-carrying capacity of all the cables is based on the same maximum permissible conductor temperature and where the range of conductor sizes in the group spans not more than three adjacent standard sizes.

A.52.5.1 (523.4.3.1) Groups in conduits, cable trunking or cable ducting

The group reduction factor which is on the safe side, for a group containing different sizes of insulated conductors or cables in conduits, cable trunking or cable ducting is:

$$F = \frac{1}{\sqrt{n}}$$

where

F is the group reduction factor

n is the number of cables or insulated conductors in the group.

The group reduction factor obtained by this equation will reduce the danger of overloading the smaller sizes but may lead to under-utilization of the larger sizes. Such under-utilization can be avoided if large and small sizes of cable or insulated conductor are not mixed in the same group.

The use of a method of calculation specifically intended for groups containing different sizes of insulated conductors or cables in conduit will produce a more precise group reduction factor. This subject is under consideration.

A.52.5.2 (523.4.3.2) Groups on trays

When a group contains different sizes of insulated conductor or cable, caution must be exercised over the current loading of smaller sizes. It is preferable to use a method of calculation specifically intended for groups containing different sizes of insulated conductors or cables.

The group reduction factor obtained in accordance with A.52.5.1 will provide a value which is on the safe side. This subject is under consideration.

A.52.6 (523.8) Methods of installation**A.52.6.1 (523.8.1) Reference methods**

The reference methods are those methods of installation for which the current-carrying capacity has been determined by test or calculation.

Reference methods A1, item 1 of table 52-3, (insulated conductors in conduit in a thermally insulated wall) and **A2**, item 2 of table 52-3, (multi-core cable in conduit in a thermally insulated wall)

The wall consists of an outer weatherproof skin, thermal insulation and an inner skin of wood or wood-like material having a thermal conductance of at least $10 \text{ W/m}^2 \cdot \text{K}$. The conduit is fixed so as to be close to, but not necessarily touching the inner skin. Heat from the cables is assumed to escape through the inner skin only. The conduit can be metal or plastic.

Reference methods B1, item 4 of table 52-3, (insulated conductors in conduit on a wooden wall) and **B2**, item 5 of table 52-3, (multi-core cable in conduit on a wooden wall)

Conduit mounted on a wooden wall so that the gap between the conduit and the surface is less than 0,3 times the conduit diameter. The conduit can be metal or plastic. Where the conduit is fixed to a masonry wall the current-carrying capacity of the cable, or insulated conductors, may be higher. This subject is under consideration.

Reference method C, item 20 of table 52-3, (single-core or multi-core cable on a wooden wall)

Cable mounted on a wooden wall so that the gap between the cable and the surface is less than 0,3 times the cable diameter. Where the cable is fixed to or embedded in a masonry wall the current-carrying capacity may be higher. This subject is under consideration.

NOTE The term "masonry" is taken to include brickwork, concrete, plaster and the like (other than thermally insulating materials).

Reference method D, item 70 of table 52-3, (multi-core cable in ducts in the ground)

Cable drawn into plastic, earthenware or metallic ducts laid in direct contact with soil having a thermal resistivity of $2,5 \text{ K} \cdot \text{m/W}$ and a depth of 0,7 m (see also A.52.3).

Reference methods E, F and G, items 32 and 33 of table 52-3, (single-core or multi-core cable in free air)

A cable so supported that the total heat dissipation is not impeded. Heating due to solar radiation and other sources shall be taken into account. Care shall be taken that natural air convection is not impeded. In practice a clearance between a cable and any adjacent surface of at least 0,3 times the cable external diameter for multi-core cables or 1 times the cable diameter for single-core cables is sufficient to permit the use of current-carrying capacities appropriate to free air conditions.

A.52.6.2 (523.8.2) Other methods

Cable on a floor or under a ceiling: this is similar to reference method C except that the rating for a cable on a ceiling is slightly reduced (see table A.52-17) from the value for a wall or a floor because of the reduction in natural convection.

Cable tray: a perforated tray has a regular pattern of holes so as to facilitate the use of cable fixings. The ratings for cables on perforated trays have been derived from test work utilizing trays where the holes occupied 30 % of the area of the base. If the holes occupy less than 30 % of the area of the base the tray is regarded as unperforated. This is similar to reference method C.

Ladder support: this is of a construction which offers a minimum of impedance to the air flow around the cables, i.e. supporting metal work under the cables occupies less than 10 % of the plan area.

Cleats and hangers: cable supports which hold the cable at intervals along its length and permit substantially complete free air flow around the cable.

General notes to tables A.52-1 to A.52-21.

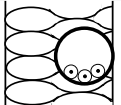
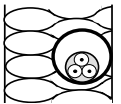
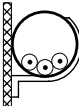
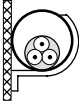
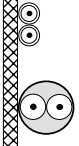
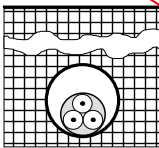
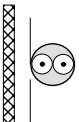
NOTE 1 Current-carrying capacities are tabulated for those types of insulated conductor and cable and methods of installation which are commonly used for fixed electrical installations. The tabulated capacities relate to continuous steady-state operation (100 % load factor) for d.c. or a.c. of nominal frequency 50 Hz or 60 Hz.

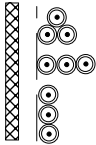
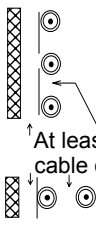
NOTE 2 Table A.52-1 itemizes the reference methods of installation to which the tabulated current-carrying capacities refer. It is not implied that all these items are necessarily recognized in national rules of all countries.

NOTE 3 (NOTE 5) For convenience where computer-aided installation design methods are employed, the current-carrying capacities in tables A.52-2 to A.52-13 can be related to conductor sized by simple formulae. These formulae with appropriate coefficients are given in annex C (annex B).

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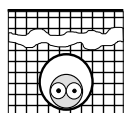
**Table A.52-1 (52-B1) – Schedule of reference methods of installation
which form the basis of the tabulated current-carrying capacities**

Reference method of installation		Table and column							Ambient temperature factor	Group reduction factor
		Current-carrying capacities for single circuits								
		PVC insulated		XLPE / EPR insulated		Mineral insulated				
		Number of cores								
		2	3	2	3	1, 2 and 3				
1	2	3	4	5	6	7	8	9		
 Room Insulated conductors in conduit in a thermally insulated wall	A1	A.52-2 Col. 2	A.52-4 Col. 2	A.52-3 Col. 2	A.52-5 Col. 2	–	A.52-14	A.52-17		
 Room Multi-core cable in conduit in a thermally insulated wall	A2	A.52-2 Col. 3	A.52-4 Col. 3	A.52-3 Col. 3	A.52-5 Col. 3	–	A.52-14	A.52-17		
 Insulated conductors in conduit on a wooden wall	B1	A.52-2 Col. 4	A.52-4 Col. 4	A.52-3 Col. 4	A.52-5 Col. 4	–	A.52-14	A.52-17		
 Multi-core cable in conduit on a wooden wall	B2	A.52-2 Col. 5	A.52-4 Col. 5	A.52-3 Col. 5	A.52-5 Col. 5	–	A.52-14	A.52-17		
 Single-core or multi-core cable on a wooden wall	C	A.52-2 Col. 6	A.52-4 Col. 6	A.52-3 Col. 6	A.52-5 Col. 6	70 °C Sheath 52-C5 105 °C Sheath 52-C6	A.52-14	A.52-17		
 Multi-core cable in ducts in the ground	D	A.52-2 Col. 7	A.52-4 Col. 7	A.52-3 Col. 7	A.52-5 Col. 7	–	A.52-15	A.52-19		
 Multi-core cable in free air Clearance to wall not less than 0,3 times cable diameter	E	Copper A.52-10 Aluminium A.52-11		Copper A.52-12 Aluminium A.52-13		70 °C Sheath A.52-8 105 °C Sheath A.52-9	A.52-14	A.52-17		

 Single-core cables, touching in free air Clearance to wall not less than one cable diameter	F	Copper A.52-10 Aluminium A.52-11	Copper A.52-12 Aluminium A.52-13	70 °C Sheath A.52-8 105 °C Sheath A.52-9	A.52-14	A.52-17
 Single-core cables, spaced in free air At least one cable diameter	G	Copper A.52-10 Aluminium A.52-11	Copper A.52-12 Aluminium A.52-13	70 °C Sheath A.52-8 105 °C Sheath A.52-9	A.52-14	–

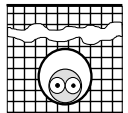
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**Table A.52-2 (52-C1) – Current-carrying capacities in amperes
for methods of installation in table A.52-1 (52-B1) –
PVC insulation/two loaded conductors/copper or aluminium –
Conductor temperature: 70 °C/Ambient temperature: 30 °C in air, 20 °C in ground**

Nominal cross-sectional area of conductor mm ²	Installation methods of table A.52-1					
	A1	A2	B1	B2	C	D
						
1	2	3	4	5	6	7
Copper						
1,5	14,5	14	17,5	16,5	19,5	22
2,5	19,5	18,5	24	23	27	29
4	26	25	32	30	36	38
6	34	32	41	38	46	47
10	46	43	57	52	63	63
16	61	57	76	69	85	81
25	80	75	101	90	112	104
35	99	92	125	111	138	125
50	119	110	151	133	168	148
70	151	139	192	168	213	183
95	182	167	232	201	258	216
120	210	192	269	232	299	246
150	240	219	–	–	344	278
185	273	248	–	–	392	312
240	321	291	–	–	461	361
300	367	334	–	–	530	408
Aluminium						
2,5	15	14,5	18,5	17,5	21	22
4	20	19,5	25	24	28	29
6	26	25	32	30	36	36
10	36	33	44	41	49	48
16	48	44	60	54	66	62
25	63	58	79	71	83	80
35	77	71	97	86	103	96
50	93	86	118	104	125	113
70	118	108	150	131	160	140
95	142	130	181	157	195	166
120	164	150	210	181	226	189
150	189	172	–	–	261	213
185	215	195	–	–	298	240
240	252	229	–	–	352	277
300	289	263	–	–	406	313

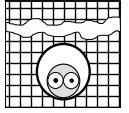
NOTE In columns 3, 5, 6 and 7, circular conductors are assumed for sizes up to and including 16 mm². Values for larger sizes relate to shaped conductors and may safely be applied to circular conductors.

**Table A.52-3 (52-C2) – Current-carrying capacities in amperes
for methods of installation in table A.52-1 (52-B1) –
XLPE or EPR insulation/two loaded conductors/copper or aluminium –
Conductor temperature: 90 °C/Ambient temperature: 30 °C in air, 20 °C in ground**

Nominal cross-sectional area of conductor mm ²	Installation methods of table A.52-1					
	A1	A2	B1	B2	C	D
						
1	2	3	4	5	6	7
Copper						
1,5	19	18,5	23	22	24	26
2,5	26	25	31	30	33	34
4	35	33	42	40	45	44
6	45	42	54	51	58	56
10	61	57	75	69	80	73
16	81	76	100	91	107	95
25	106	99	133	119	138	121
35	131	121	164	146	171	146
50	158	145	198	175	209	173
70	200	183	253	221	269	213
95	241	220	306	265	328	252
120	278	253	354	305	382	287
150	318	290	–	–	441	324
185	362	329	–	–	506	363
240	424	386	–	–	599	419
300	486	442	–	–	693	474
Aluminium						
2,5	20	19,5	25	23	26	26
4	27	26	33	31	35	34
6	35	33	43	40	45	42
10	48	45	59	54	62	56
16	64	60	79	72	84	73
25	84	78	105	94	101	93
35	103	96	130	115	126	112
50	125	115	157	138	154	132
70	158	145	200	175	198	163
95	191	175	242	210	241	193
120	220	201	281	242	280	220
150	253	230	–	–	324	249
185	288	262	–	–	371	279
240	338	307	–	–	439	322
300	387	352	–	–	508	364

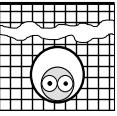
NOTE In columns 3, 5, 6 and 7, circular conductors are assumed for sizes up to and including 16 mm². Values for larger sizes relate to shaped conductors and may safely be applied to circular conductors.

**Table A.52-4 (52-C3) – Current-carrying capacities in amperes
for methods of installation in table A.52-1 (52-B1) –
PVC insulation/three loaded conductors/copper or aluminium –
Conductor temperature: 70 °C/Ambient temperature: 30 °C in air, 20 °C in ground**

Nominal cross-sectional area of conductor mm ²	Installation methods of table A.52-1					
	A1	A2	B1	B2	C	D
						
1	2	3	4	5	6	7
Copper						
1,5	13,5	13	15,5	15	17,5	18
2,5	18	17,5	21	20	24	24
4	24	23	28	27	32	31
6	31	29	36	34	41	39
10	42	39	50	46	57	52
16	56	52	68	62	76	67
25	73	68	89	80	96	86
35	89	83	110	99	119	103
50	108	99	134	118	144	122
70	136	125	171	149	184	151
95	164	150	207	179	223	179
120	188	172	239	206	259	203
150	216	196	–	–	299	230
185	245	223	–	–	341	258
240	286	261	–	–	403	297
300	328	298	–	–	464	336
Aluminium						
2,5	14	13,5	16,5	15,5	18,5	18,5
4	18,5	17,5	22	21	25	24
6	24	23	28	27	32	30
10	32	31	39	36	44	40
16	43	41	53	48	59	52
25	57	53	70	62	73	66
35	70	65	86	77	90	80
50	84	78	104	92	110	94
70	107	98	133	116	140	117
95	129	118	161	139	170	138
120	149	135	186	160	197	157
150	170	155	–	–	227	178
185	194	176	–	–	259	200
240	227	207	–	–	305	230
300	261	237	–	–	351	260

NOTE In columns 3, 5, 6 and 7, circular conductors are assumed for sizes up to and including 16 mm². Values for larger sizes relate to shaped conductors and may safely be applied to circular conductors.

**Table A.52-5 (52-C4) – Current-carrying capacities in amperes
for methods of installation in table A.52-1 (52-B1) –
XLPE or EPR insulation/three loaded conductors/copper or aluminium –
Conductor temperature: 90 °C/Ambient temperature: 30 °C in air, 20 °C in ground**

Nominal cross-sectional area of conductor mm ²	Installation methods of table A.52-1					
	A1	A2	B1	B2	C	D
						
1	2	3	4	5	6	7
Copper						
1,5	17	16,5	20	19,5	22	22
2,5	23	22	28	26	30	29
4	31	30	37	35	40	37
6	40	38	48	44	52	46
10	54	51	66	60	71	61
16	73	68	88	80	96	79
25	95	89	117	105	119	101
35	117	109	144	128	147	122
50	141	130	175	154	179	144
70	179	164	222	194	229	178
95	216	197	269	233	278	211
120	249	227	312	268	322	240
150	285	259	–	–	371	271
185	324	295	–	–	424	304
240	380	346	–	–	500	351
300	435	396	–	–	576	396
Aluminium						
2,5	19	18	22	21	24	22
4	25	24	29	28	32	29
6	32	31	38	35	41	36
10	44	41	52	48	57	47
16	58	55	71	64	76	61
25	76	71	93	84	90	78
35	94	87	116	103	112	94
50	113	104	140	124	136	112
70	142	131	179	156	174	138
95	171	157	217	188	211	164
120	197	180	251	216	245	186
150	226	206	–	–	283	210
185	256	233	–	–	323	236
240	300	273	–	–	382	272
300	344	313	–	–	440	308

NOTE In columns 3, 5, 6 and 7, circular conductors are assumed for sizes up to and including 16 mm². Values for larger sizes relate to shaped conductors and may safely be applied to circular conductors.

**Table A.52-6 (52-C5) – Current-carrying capacities in amperes for
installation method C of table A.52-1 (52-B1) –
Mineral insulation/copper conductors and sheath –
PVC covered or bare exposed to touch (see note 2)
Metallic sheath temperature: 70 °C/Reference ambient temperature: 30 °C**

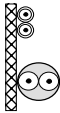
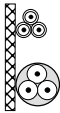
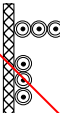
Nominal cross-sectional area of conductor mm ²	Number and arrangement of conductors for method C of table A.52-1		
	Two loaded conductors twin or single-core	Three loaded conductors	
		Multi-core or single-core in trefoil formation	Single-core in flat formation
			
1	2	3	4
500 V			
1,5	23	19	21
2,5	31	26	29
4	40	35	38
750 V			
1,5	25	21	23
2,5	34	28	31
4	45	37	41
6	57	48	52
10	77	65	70
16	102	86	92
25	133	112	120
35	163	137	147
50	202	169	181
70	247	207	221
95	296	249	264
120	340	286	303
150	388	327	346
185	440	371	392
240	514	434	457
NOTE 1 For single-core cables the sheaths of the cables of the circuit are connected together at both ends.			
NOTE 2 For bare cables exposed to touch, values should be multiplied by 0,9.			

**Table A.52-7 (52-C6) – Current-carrying capacities in amperes
for installation method C of table A.52-1 (52-B1) –
Mineral insulation/copper conductors and sheath –
Bare cable not exposed to touch and not in contact with combustible material
Metallic sheath temperature: 105 °C/Reference ambient temperature: 30 °C**

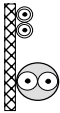
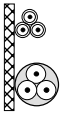
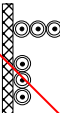
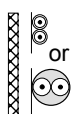
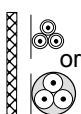
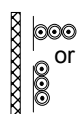
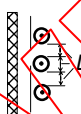
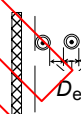
Nominal cross-sectional area of conductor mm ²	Number and arrangement of conductors for method C of table A.52-1		
	Two loaded conductors twin or single-core	Three loaded conductors	
		Multi-core or single-core in trefoil formation	Single-core in flat formation
			
1	2	3	4
500 V			
1,5	28	24	27
2,5	38	33	36
4	51	44	47
750 V			
1,5	31	26	30
2,5	42	35	41
4	55	47	53
6	70	59	67
10	96	81	91
16	127	107	119
25	166	140	154
35	203	171	187
50	251	212	230
70	307	260	280
95	369	312	334
120	424	359	383
150	485	410	435
185	550	465	492
240	643	544	572
NOTE 1 For single-core cables, the sheaths of the cables of the circuit are connected together at both ends.			
NOTE 2 No correction for grouping need be applied.			
NOTE 3 For this table reference method C refers to a masonry wall because the high sheath temperature is not normally acceptable for a wooden wall.			

**Table A.52-8 (52-C7) – Current-carrying capacities in amperes
for installation methods E, F and G of table A.52-1 (52-B1) –
Mineral insulation/Copper conductors and sheath/PVC covered
or bare exposed to touch (see note 2)
Metallic sheath temperature: 70 °C/Reference ambient temperature: 30 °C**

Nominal cross-sectional area of conductor mm ²	Number and arrangement of cables for methods E, F and G of table A.52-1				
	Two loaded conductors twin or single-core Method E or F	Three loaded conductors			
		Multi-core or single-core in trefoil formation Method E or F	Single-core touching Method F	Single-core flat vertical spaced Method G	Single-core horizontal spaced Method G
					
1	2	3	4	5	6
500 V					
1,5	25	21	23	26	29
2,5	33	28	31	34	39
4	44	37	41	45	51
750 V					
1,5	26	22	26	28	32
2,5	36	30	34	37	43
4	47	40	45	49	56
6	60	51	57	62	71
10	82	69	77	84	95
16	109	92	102	110	125
25	142	120	132	142	162
35	174	147	161	173	197
50	215	182	198	213	242
70	264	223	241	259	294
95	317	267	289	309	351
120	364	308	331	353	402
150	416	352	377	400	454
185	472	399	426	446	507
240	552	466	496	497	565
NOTE 1 For single-core cables the sheaths of the cables of the circuit are connected together at both ends.					
NOTE 2. For bare cables exposed to touch, values should be multiplied by 0,9.					
NOTE 3 D_e is the external diameter of the cable.					