AS/NZS 3008.1.2:2017

Australian/New Zealand Standard

Electrical installations—Selection of cables

Part 1.2: Cables for alternating voltages up to and including 0.6/1 kV—Typical New Zealand conditions

Superseding AS/NZS 3008.1.2:2010

STANDARDS NEW ZEALAND
PAEREWA AOTEAROA

AS/NZS 3008.1.2:2017

STANDARDS Australia

This joint Australian/New Zealand Standard was prepared by joint Technical Committee EL-001, Wiring Rules. It was approved on behalf of the Council of Standards Australia on 1 December 2016 and by the New Zealand Standards Approval Board on 17 November 2016.

This standard was published on 2 February 2017.

The following are represented on Committee EL-001:

Australian Building Codes Board
Australian Industry Group
Communications, Electrical and Plumbing Union—Electrical Division
Consumers Federation of Australia
Electrical Contractors Association of New Zealand
Electrical Regulatory Authorities Council
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This standard was issued in draft form for comment as DR AS/NZS 3008.1.2:2015.

Australian/New Zealand Standard

Electrical installations—Selection of cables

Part 1.2: Cables for alternating voltages up to and including 0.6/1 kV—Typical New Zealand conditions

Originated in Australia as AS 3008.1—1984.
Second edition 1989.
Jointly revised and redesignated AS/NZS 3008.1.2:1998.
Previous edition 2010.
This edition 2017.

Jointly published by SAI Global Limited under licence from Standards Australia Limited, GPO Box 476, Sydney, NSW 2001 and by Standards New Zealand, PO Box 1473, Wellington 6140.

ISBN (Print) 978-1-77664-809-2
ISBN (PDF) 978-1-77664-810-8

PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-001, Wiring Rules, to supersede AS/NZS 3008.1.2:2010, *Electrical installations—Selection of cables*, Part 1.2: *Cables for alternating voltages up to and including 0.6/1 kV—Typical New Zealand conditions*. This Standard is applicable to New Zealand installation conditions where the nominal ambient air and soil temperatures are 30°C and 15°C, respectively. AS/NZS 3008.1.1 is applicable to Australian installation conditions where the nominal air and soil temperatures are 40°C and 25°C respectively. Each Part is a complete Standard and requires no reference to the other.

This Standard deals with cables for use with alternating voltages over 1 kV.

The objective of this Standard is to specify current-carrying capacity, voltage drop and short-circuit temperature rise of cables, to provide a method of selection for those types of electric cables and methods of installation that are in common use at working voltages up to and including 0.6/1 kV at 50 Hz a.c.

This Standard differs from the 2010 edition as follows:

(a) Economic optimization for cable selection recommendations, including a new example in Appendix A.

(b) A new definition for Circuit.

(c) Cable core cross sections have been updated for the following:

  (i) Figure 1.

  (ii) Table 3(1).

  (iii) Table 3(2).

  (iv) Table 3(4).

  (v) Table 10.

  (vi) Table 11.

  (vii) Table 12.

  (viii) Table 13.

  (ix) Table 14.

  (x) Table 15.

  (xi) Table 17.

  (xii) Table 26(2).

(d) New notes to Tables 30, 31, 40, 41, 43, 44, 46, 47, 50 and 51 have been included.

(e) Changes to derating factors in Table 23.

(f) Circuit recommendations for low magnetic fields added to Appendix D.

In the preparation of this Standard, reference was made to IEC 60287 and acknowledgement is made of the assistance received from that source.

Statements expressed in mandatory terms in notes to Tables and Figures are deemed to be requirements of this Standard.

The term 'informative' has been used in this Standard to define the application of the appendix to which it applies. An 'informative' appendix is only for information and guidance.

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SECTION 1 SCOPE AND APPLICATION

1.1 SCOPE

This Standard sets out a method for cable selection for those types of electrical cables and methods of installation that are in common use at working voltages up to and including 0.6/1 kV at 50 Hz a.c.

Four criteria are given for cable selection, as follows:

(a) Current-carrying capacity.

(b) Voltage drop.

(c) Short-circuit temperature rise.

(d) Economic optimization.

This Standard provides sustained current-carrying capacities and voltage drop values for those types of electrical cable and installation practices in common use in New Zealand. A significant amount of explanatory material is also provided on the application of rating factors that arise from the particular installation conditions of a single circuit or groups of circuits. Also, provided in Section 5 is information on cable selection based on short-circuit temperature limits.

NOTE: A number of worked examples on cable selection are included in Appendix A.

This Standard does not take into account the effects that may occur owing to temperature rise at the terminals of equipment and reference is necessary to AS/NZS 3000 and the individual equipment Standards.

NOTE: For ease of reference, an index of the Tables included in this Standard is provided in Appendix B.

1.2 APPLICATION

This Standard is intended to apply to installations made or carried out after the date of publication, but it is recommended that it not be applied on a mandatory basis until 6 months after the date of publication. However, if work on an installation commenced before publication of this edition, the inspecting authority may grant permission for the installation to be carried out in accordance with the superseded edition.

1.3 ALTERNATIVE SPECIFICATIONS

AS/NZS 3000 gives current-carrying capacities for a limited number of cable installation conditions. These conditions are included in this Standard but, in some cases, where recalculations have been performed, the tabulated values differ slightly between the Standards. Where this occurs the current-carrying capacity given in this Standard is considered to be more accurate, but either value is acceptable for the application of any appropriate requirements of AS/NZS 3000, e.g. maximum current rating of a circuit-protective device.

Where the type of cable or method of installation is not specifically covered in the Tables of this Standard, current-carrying capacities obtained from alternative specifications such as ERA Report 69-30 may be employed.

ERA Report 69-30, particularly Part III, gives information on the following areas that are not covered by this Standard:

(a) The d.c. current-carrying capacities of two single-core cables and one two-core cable.

(b) The current-carrying capacity of armoured single-core cables.

(c) Group rating factors for underground cables laid in tier formation.

Current-carrying capacities may also be determined by calculation using IEC 60287 or applying correction factors to the published data from IEC 60364-5-52 for local conditions.

The subject of assigning a current-carrying capacity to a cyclically or intermittently loaded cable is not covered in this Standard as it normally relates to HV cable installation. However, reference may be made to ERA Report F/T 186 for information on the determination of such cable ratings by calculation.

1.4 REFERENCED AND RELATED DOCUMENTS

1.4.1 Referenced documents

The following documents are referred to in this Standard:

AS/NZS

1125	Conductors in insulated electric cables and flexible cords
3000	Electrical installations (known as the Australian/New Zealand Wiring Rules)
3008	Electrical installations—Selection of cables
3008.1.1	Part 1.1: Cables for alternating voltages up to and including 0.6/1 kV—Typical Australian installation conditions

IEC

60287	Electric cables—Calculation of the current rating (all Parts)
60364	Electrical installations of buildings
60364-4-43	Part 4-43: Protection for safety—Protection against overcurrent
60364-5-52	Part 5-52: Selection and erection of electrical equipment—Wiring systems

ERA REPORTS

69-30	Current rating standards for distribution cables Part III: Sustained current ratings for PVC insulated cables to BS 6346:1969 (AC 50 Hz and DC)
69-30	Current rating standards for distribution cables Part V: Sustained current ratings for cables with thermo-setting insulation to BS 5467:1989 and BS 6724:1986 (AC 50 Hz and DC)

F/T
186 Methods for the calculation of cyclic rating factors and emergency loading for cables laid direct in the ground or in ducts

1.4.2 Related documents

Attention is drawn to the following related documents.

AS
1531 Conductors—Bare overhead—Aluminium and aluminium alloy

1746 Conductors—Bare overhead—Hard-drawn copper

3158 Electric cables—Glass fibre insulated—For working voltages up to and including 0.6/1 (1.2) kV

AS/NZS
3191 Electric flexible cords

3560 Electric cables—Cross-linked polyethylene insulated—Aerial bundled—For up to and including 0.6/1 (1.2) kV
3560.1 Part 1: Aluminium conductors
3560.2 Part 2: Copper conductors

4026 Electric cables—For underground residential distribution systems

4961 Electric cables—Polymeric insulated—For distribution and service applications

5000 Electric cables—Polymeric insulated
5000.1 Part 1: For working voltages up to and including 0.6/1 (1.2) kV
5000.2 Part 2: For working voltages up to and including 450/750 V
5000.3 Part 3: Multicore control cables

60702 Mineral insulated cables and their terminations with a rated voltage not exceeding 750 V
60702.1 Part 1: Cables

IEC
60724 Short-circuit temperature limits of electric cables with rated voltages of 1.0 kV (U_m = 1,2 kV) and 3 kV (U_m = 3,6 kV)

INDUSTRY REPORTS
ICAA Principles of economic and energy-efficient cable sizing http://www.copper.com.au/copper/wcms/en/home/Principles-of-Economic-and-Energy-Efficient-Cable-Sizing.pdf

1.5 DEFINITIONS

For the purpose of this Standard, the definitions in AS/NZS 3000 and those below apply.

1.5.1 Ambient temperature

The temperature of the medium in the immediate neighbourhood of the installed cable—

(a) including any increase in temperature due to materials or equipment to which the cables are connected, or are to be connected; but

(b) excluding any increase in temperature that may be due to the heat arising from the cables at that point.

1.5.2 Circuit

For the purposes of determining the derating factor due to mutual heating effects, any multicore cable with 2 or 3 current-carrying cores or a group of single-core cables with 2 or 3 current carrying cables.

Any cable that is installed or stored in a manner that causes self-heating, such as cables wound onto a drum, is considered as a separate circuit for each instance where self-heating cannot be ignored.

1.5.3 Continuous loading

A continuous constant current (100% load factor) just sufficient to produce asymptotically the maximum conductor temperature, the surrounding ambient conditions being assumed constant.

1.5.4 Installation wiring

A system of wiring in which the cables are fixed or supported in position in accordance with the appropriate requirements of this Standard.

NOTE: Replaces the term 'fixed wiring'.

1.5.5 Ladder support

A support in which the impedance to the air flow around the cable is not greater than 10%, i.e. supporting metalwork under the cable occupies less than 10% of the plan area.

1.5.6 Perforated tray

A tray having not less than 30% of its surface area removed by the perforation.

1.5.7 Route length

The distance measured along a run of wiring from the origin of the circuit to the point of consideration, e.g. the distance measured between a switchboard and a motor.

SECTION 2 CABLE SELECTION PROCEDURE

2.1 GENERAL

The cable selection procedures set out in this Section detail the guidelines to be followed to determine the minimum size of cable required to satisfy a particular installation condition.

2.2 SELECTION PROCESS

The following three main factors influence the selection of a particular cable to satisfy the circuit requirements:

(a) *Current-carrying capacity* Dependent upon the method of installation and the presence of external influences, such as thermal insulation, which restrict the operating temperature of the cable.

(b) *Voltage drop* Dependent upon the impedance of the cable, the magnitude of the load current and the load power factor.

(c) *Short-circuit temperature limit* Dependent upon energy produced during the short-circuit condition.

The minimum cable size will be the smallest cable that satisfies the three requirements. However, with experience it will become apparent that the different nature of installations will determine which of the requirements predominate. The current-carrying capacity requirement will be the most demanding in the relatively shorter route lengths of domestic premises and the like where factors such as cable grouping, and thermal insulation occur. On the other hand the voltage drop limitation is usually the deciding factor for longer route lengths that are not subject to the factors mentioned above. The need to increase cable size to meet the short-circuit temperature rise requirements will only occur in special situations for the voltage ratings of the cables covered by this Standard.

NOTE: Optional economic cable sizing considerations are detailed in Clause 2.6 of this Standard.

2.3 DETERMINATION OF MINIMUM CABLE SIZE BASED ON CURRENT-CARRYING CAPACITY CONSIDERATIONS

To satisfy the current-carrying capacity requirements of a circuit it is necessary to take into account a number of factors, as follows:

NOTE: See Appendix A for examples, in particular Example 3, which shows the method used in this Clause.

(a) Determine the current requirements of the circuit.

NOTE: Refer to the Clause in AS/NZS 3000 covering protection against overload current.

$I_B \leq I_Z$

I_B = the current for which the circuit is designed, e.g. maximum demand

I_Z = the continuous current-carrying capacity of the cable determined by Clause 2.3(d)

(b) From Tables 3(1), 3(2), 3(3) and 3(4) determine the cable installation method to be used applicable to the common cross-linked elastomeric or thermoplastic-insulated cables.

NOTE: Determine the current-carrying Table and appropriate column of the Table for use in Clause 2.3(d).

(i) For a single circuit, determine if the method of installation requires the application of a derating factor selected from Tables 22, 23 or 24. Where applicable, divide the value of current determined in Step (a) by the derating factor so determined.

(ii) For a group of circuits, determine if the method of installation requires the application of a derating factor selected from Tables 22 to 26. Where applicable, divide the value of current I_B by the derating factor so determined.

(c) Determine the environmental conditions in the vicinity of the cable installation. Where applicable, divide the value of current determined in Step (b) by—

(i) the ambient air or soil temperature rating factor selected from Tables 27(1) and 27(2);

(ii) the depth of laying rating factor selected from Tables 28(1) and 28(2); and

(iii) the soil thermal resistivity rating factor selected from Table 29.

(d) The resulting value of current, determined from the calculations in Clauses 2.3(b) and 2.3(c), is used to select a cable from the current-carrying capacity Tables. This ensures that the cable will carry the design current I_B in accordance with Clause 2.3(a) after derating.

See the Tables of current-carrying capacity for the different cable types, i.e. Tables 4 to 21. Taking into account the method of installation employed, the smallest conductor size that has a tabulated current-carrying capacity equal to or in excess of this pre-determined minimum value will be considered to be the minimum cable size satisfying the current-carrying capacity requirement.

NOTE: I_Z is the tabulated rating multiplied by the derating factors.

2.4 DETERMINATION OF MINIMUM CABLE SIZE BASED ON VOLTAGE DROP CONSIDERATIONS

To satisfy the voltage drop limitations of a circuit, it is necessary to take into account the current required by the load and the route length of the circuit, as follows:

(a) Determine the current (I) requirements of the circuit.

(b) Determine the route length (L) of the circuit.

(c) Determine the maximum voltage drop (V_d) permitted on the circuit run.

NOTE: Unless otherwise permitted by AS/NZS 3000, the maximum voltage drop between the point of supply for the low voltage electrical installation and any point in that electrical installation should not exceed 5% of the nominal voltage at the point of supply.

(d) Determine the voltage drop (V_c) in millivolts per ampere metre (mV/A.m) using Equation 4.2(1) and the values of I, L and V_d determined in Steps (a), (b) and (c).

(e) See the Tables of voltage drop (mV/A.m) for the different cable types, Tables 40 to 51. Taking into account the method of installation, maximum conductor operating temperature and load power factor, the smallest conductor size that has a tabulated voltage drop (mV/A.m) value nearest to, but not exceeding, the value determined in Step (d) will be considered to be the minimum cable size satisfying the voltage drop limitation.

This simplified method gives an approximate but conservative solution assuming maximum cable operating temperatures and the most onerous relationship between load and cable power factors. A more accurate assessment can be made of the actual voltage drop (V_d) using the appropriate equation of Clause 4.5, the cable reactance determined from Tables 30 to 33, the cable a.c. resistance determined from Tables 34 to 39 using the approximate conductor operating temperature assessed from Equation 4.4(1), and the load power factor.

NOTES:

1 If the value of voltage drop assessed using the appropriate equation of Clause 4.5 is significantly lower than the equivalent value determined using the simplified method suggested in Steps (a) to (e), consideration should be given to the calculation of voltage drop for the next smaller cable size.

2 Because of the need to make an initial set of assumptions relating to cable size, the calculation method of Clause 4.5 will normally only be of use to check the accuracy of the simplified method or to check the voltage drop on an existing or known cable installation.

2.5 DETERMINATION OF MINIMUM CABLE SIZE BASED ON THE SHORT-CIRCUIT TEMPERATURE CONSIDERATIONS

To satisfy the short-circuit temperature limit it is necessary to take into account the energy producing the temperature rise (I^2t) and the initial and final temperatures, as follows:

(a) Determine the maximum duration and value of the prospective short-circuit current.

(b) Determine the initial and final conductor temperatures and select an appropriate value of the constant (K) from Table 52.

(c) Calculate the minimum cross-sectional area of the cable using Equation 5.3(1). This cable size represents the minimum size required to satisfy the short-circuit temperature rise requirements.

2.6 DETERMINATION OF CABLE SIZE BASED ON THE ECONOMIC OPTIMIZATION CONSIDERATIONS (OPTIONAL)

The increasing cost of energy, together with the high energy losses which follow from the use of modern cables operating at high temperatures, now raises the value that cable size selection be considered on wider economic grounds.

The background for economic cable sizing is provided in IEC 60287-3-2.

The key points of selecting a cable size by economic optimization in accordance with IEC 60287-3-2 are as follows:

The minimum allowable cable size is given by applying safety-based rules in accordance with Clauses 2.2 to 2.5 of this Standard. This minimum allowable cable size also has least initial cost—a larger cable would cost more. The optimal economic cable size is found by minimizing the lifetime costs of the cable which includes both its initial cost and the operating cost (i.e. cost of losses).

The initial cost may simply be the present cost of the selected cable, but often includes additional costs, such as labour for installation, termination and additional cable supports, etc. The cost of future losses is determined by the sum of the discounted future cost of the losses. Because inflation affects the cost of borrowing money and the cost of energy they cancel each other and therefore does not need to be accounted for. Therefore, the future costs are based on the sum of the future load, future energy costs and the discount rate.

When a cable is selected using economic principles it should always be equal or larger in cross section that one selected on the basis of safety. For the 132 kV example given in IEC 60287-3-2 the saving in the combined cost of purchase and operation is of the order of 50%.

NOTE: An example of the application of economic optimization of cable sizing is provided in Appendix A9.

SECTION 3 CURRENT-CARRYING CAPACITY

3.1 RATINGS

3.1.1 General

The provisions of this Section apply to the selection of conductor sizes with regard to current-carrying capacity.

Clauses 3.2 to 3.5 stipulate conductor and cable requirements and installation conditions in order that the subsequent Tables of current-carrying capacity may be applied.

Tables 3(1), 3(2), 3(3) and 3(4) give guidance on the appropriate table of current-carrying capacity for different installation methods for the common types of cable insulation covered by Tables 4 to 15. A specific installation condition is defined and illustrated and alternative installation conditions deemed to have the same current-carrying capacity are also given. Attention is drawn to Tables of rated current-carrying capacity where the standard installation conditions of Clause 3.4 are varied.

Tables 4 to 21 give the current-carrying capacities for the variety of different cable types described in Clause 3.3.

3.1.2 Basis

The values for current ratings given in Tables 4 to 15 have been calculated using the method described in IEC 60287 except for cables partially or completely surrounded by thermal insulation and flat cables that have been assigned the same ratings as circular cables.

NOTES:

1 Unless otherwise stated, PVC wiring enclosures have been used for installation in air and underground.

Furthermore, it should be noted that the current ratings for 110°C rated cables enclosed in conduit in air assume the use of metallic conduit. The use of non-metallic conduits is not recommended.

2 The current ratings in Standard may also be used for d.c. installations as calculations will yield negligible difference or conservative results.

3 AS/NZS 3000 has requirements for protection against overload current and coordination between conductors and protective means. For example, the overload characteristics of circuit breakers and fuses are different.

3.2 TYPES OF CONDUCTORS

3.2.1 Conductor material

The current-carrying capacities are based on conductors of high-conductivity copper and aluminium in sizes, strandings and resistances in accordance with AS/NZS 1125.

3.2.2 Insulation material operating temperatures

The sustained current-carrying capacities are based on the ‘normal use’ temperatures specified in Column 2 of Table 1. Where the ‘maximum permissible’ temperature in Column 3 of Table 1 is greater than the ‘normal use’ temperature, the ‘maximum permissible’ temperature may only be used under the conditions described in Note 3 to Table 1 for thermoplastic cables and in Note 7 to Table 1 for MIMS cables.

NOTE: Where cables are consistently operating substantially below the limiting temperature of Table 1, the heat losses (I2R) and voltage drop (IZ) will also be reduced. These features could be relevant in determining the optimum economic design of a circuit.

TABLE 1

LIMITING TEMPERATURES FOR INSULATED CABLES

1	2	3	4
Type of cable insulation	**Operating temperatures of conductors, °C (see Note 1)**		
	Normal use	**Maximum permissible (see Note 2)**	**Minimum ambient**
Thermoplastic (see Note 3)			
V-75	75	75	0
HFI-75-TP, TPE-75	75	75	–20
V-90	75	90	0
HFI-90-TP, TP-90	75	90	–20
V-90HT	75	105	0
Cross-linked elastomeric (see Note 4)			
R-EP-90	90	90	–40
R-CPE-90, R-HF-90, R-CSP-90	90	90	–20
R-HF-110, R-E-110 (see Note 5)	110	110	*
R-S-150 (see Note 6)	150	150	–50
Cross-linked polyolefin (XLPE) (see Note 4)			
X-90, X-90UV, X-HF-90	90	90	*
X-HF-110 (see Note 5)	110	110	*
Mineral-insulated metal-sheathed (MIMS)			
(see Note 7)	100 (sheath)	250 (sheath)	–
Other types			
PE, LLDPE	70	70	*
Type 150 fibrous or polymeric (see Note 6)	150	150	–

* Refer to manufacturer's information.

NOTES TO TABLE 1:

1 The temperature limits specified in Table 1 relate to the sustained current-carrying capacity and do not represent the maximum permissible temperatures permitted under short-circuit conditions. A guide to the acceptable short-circuit temperature limits is given in Section 5.

2 The maximum permissible temperatures given in Column 3 are applicable when there is no chance of thermal deformation or a reasonable chance of human contact in normal use.

For safety reasons, where flexible cords may be exposed and are likely to be touched, the maximum permissible temperature should be limited (see Table 16, Note 3).

3 The normal operating temperature of thermoplastic cables, including flexible cords installed as installation wiring, are based on a conductor temperature of 75°C. This is due to the risk of thermal deformation of insulation if the cables are clipped, fixed or otherwise installed in a manner that exposes the cable to severe mechanical pressure at higher temperatures.

V-90 and V-90HT insulated cables may be operated up to the maximum permissible temperatures 90°C and 105°C provided that the cable is installed in a manner that is not subject to, or is protected against, severe mechanical pressure at temperatures higher than 75°C. Such applications also allow for cables to be used in—

(a) locations where the ambient temperatures exceeds the normal 30°C, e.g. equipment wiring in luminaires and heating appliances, or in roof spaces affected by high summer temperatures; and

(b) locations affected by bulk thermal insulation that restricts the dissipation of heat from the cable.

4 Cross-linked elastometric and cross-linked polyolefin materials have the property of maintaining their shape at higher temperatures and do not flow under mechanical pressure.

5 Cables with an operating temperature of 110°C should only be connected to equipment suitable for this temperature. Consideration should also be given to the voltage drop at this operating temperature.

6 The current-carrying capacities given in Table 17 for cables insulated with high temperature cross-linked elastomeric, polymeric or fibrous materials are based on cables operating at temperatures of 150°C in an ambient temperature of 30°C and where the hot cable surfaces are acceptable. However, the cables are generally installed in areas of high ambient temperature, such as equipment wiring, and it will be necessary to apply an appropriate temperature correction factor from Tables 27(1) and 27(2).

7 The current-carrying capacities for fibrous and polymeric (fluoropolymer) type cables and cords suitable for operation at 200°C are not given in this Standard. As an alternative to the use of the relatively conservative values given in Table 17, advice may be sought from cable manufacturers.

8 The current-carrying capacities for MIMS cables are based on an operating temperature of 100°C for the external surface of either bare metal-sheathed cables or served cables. Higher continuous operating temperatures are permissible for bare metal-sheathed cables, particularly stainless steel sheathed cables, dependent upon factors such as the following:

(a) The suitability of the cable terminations and mountings.

(b) The location of the cable away from combustible materials.

(c) The location of the cable away from areas where there is a reasonable chance of persons touching the exposed surface.

(d) Other environmental and external influences.

3.3 TYPES OF CABLE

3.3.1 Sheathed or unsheathed thermoplastic, cross-linked elastomeric and XLPE insulated cables

3.3.1.1 *General*

The current-carrying capacity of sheathed or unsheathed thermoplastic, cross-linked elastomeric or XLPE insulated cables shall be determined from Tables 4 to 15.

3.3.1.2 *Method of installation*

The current-carrying capacity of a given cable depends on the method of installation. Tables 3(1), 3(2), 3(3) and 3(4) provide a schedule of the installation methods applicable to sheathed or unsheathed cross-linked elastomeric or thermoplastic insulated cables whose current-carrying capacities are given in Tables 4 to 15. Tables 3(1), 3(2), 3(3) and 3(4) also draw attention to the different methods of installation that may be assigned the same current-carrying capacity and refers to Tables of derating factors applicable where one circuit is run in close proximity to another circuit or circuits.

3.3.2 Flexible cords and cables

3.3.2.1 *Used for installation wiring*

The determination of current-carrying capacity of flexible cords and cables used for installation wiring shall be as given in Tables 4 to 15 and 17.

3.3.2.2 *Other than installation wiring*

The determination of current-carrying capacity of flexible cords and cables used for other than installation wiring shall be as follows:

(a) *General* Except as provided in Item (b), the current-carrying capacity of flexible cords and cables not used as installation wiring shall be determined from Tables 16 and 17. The current-carrying capacity of flexible cables shall be determined from Tables 4 to 15.

(b) *Connection of equipment* Where a flexible cord is—

 (i) used for the connection of equipment to the installation wiring by means of a plug and socket; and

 (ii) the equipment comes within the scope of associated Standards, e.g. AS/NZS 60335 series,

 the current-carrying capacity shall be determined from the appropriate Standard.

3.3.3 Mineral-insulated metal-sheathed (MIMS) cables

The current-carrying capacity of bare or served copper MIMS cables shall be determined from Tables 18 and 19.

NOTE: Current-carrying capacities are not given in this Standard for polyethylene served or other forms of MIMS cable used for heating purposes, such as trace heating, tank heating or floor warming.

3.3.4 Aerial cables

The current-carrying capacity of aerial cables shall be determined from Tables 20 and 21. See Clause 3.3.5 for the determination of the current-carrying capacity of neutral-screened aerial cables.

3.3.5 Neutral-screened cables

The current-carrying capacity of neutral-screened cables shall be determined from the number of cable cores and method of installation as follows:

(a)	For single-core neutral-screened cables (i.e. 2-conductor)	Tables 10, 11 and 12
(b)	For 2-core, 3-core or 4-core neutral-screened cables (i.e. 3-conductor, 4-conductor and 5-conductor)	Tables 13, 14 and 15

However, the current-carrying capacity of neutral-screened aerial cables shall be determined as follows:

(i) For single-core (i.e. 2-conductor) neutral-screened cable	Columns 8 to 10 and 15 to 17 of Table 20 or Table 21, as appropriate
(ii) For 2-core, 3-core or 4-core (i.e. 3-, 4- or 5-conductor) neutral screened cable	Columns 12 to 14 and 18 to 20 of Table 20 or Table 21, as appropriate

3.3.6 High temperature cross-linked elastomeric, polymeric or fibrous insulated cables and flexible cords

The current-carrying capacity of R-S-150 cross-linked elastomeric insulated cables, Type 150 heat-resisting fibrous insulated cables and 150°C rated fluoropolymer insulated flexible cords shall be determined from Table 17.

3.3.7 Other cable types

This Standard provides current-carrying capacities for types of cables that are considered to be in common use. For cables not included in this Standard, cable manufacturers should be consulted for recommendations on the current-carrying capacity and acceptable methods of installation.

3.4 INSTALLATION CONDITIONS

3.4.1 General

The current-carrying capacity of a cable is dependent on the method of installation to maintain the temperature of the cable within its operating limits. Different methods of installation vary the rate at which the heat generated by the current flow is dissipated to the surrounding medium.

Specific conditions of installation are laid down in Clauses 3.4.2 to 3.4.5 for cables installed with or without wiring enclosures in air, in the ground or embedded in building materials. These conditions have been used to derive the current-carrying capacities tabulated in Section 3. Where a number of installation conditions exist along a cable run or variations to the specific conditions occur, reference shall be made to Clauses 3.4.6 and 3.5 respectively.

3.4.2 Cables installed in air

For cables installed in free air, the current-carrying capacities shall be based on the following conditions of installation and operation:

(a) *Ambient temperature* An ambient air temperature of 30°C.

(b) *Unenclosed cables* Cables installed as follows:

  (i) Directly in air and, except for flexible cables as mentioned in Note 2 to Table 1 and aerial cables, not exposed to direct sunlight and where they are—

    (A) lying on a horizontal surface;

    (B) lying across ceiling joists;

    (C) supported on perforated or unperforated cable trays, ladders, hangers or racks;

    (D) clipped at intervals to a vertical or horizontal surface, such as a wall or beneath a ceiling;

    (E) suspended from a catenary wire;

    (F) lying in the bottom of open trunking;

    (G) in an enclosure such as a switchboard; or

(H) in a ventilated hatch.

(ii) Directly embedded beneath the surface of plaster, cement render or masonry.

NOTE: Table 3(1) contains a reference to the appropriate current-carrying capacity table for cables installed unenclosed in air.

(c) *Enclosed cables* Cables installed as follows:

(i) In metallic or non-metallic wiring enclosure in—

(A) free air;

(B) a ventilated or enclosed trench;

(C) a concrete slab on or above the surface of the ground; or

(D) a concrete, plaster, cement rendered or masonry wall.

(ii) In closed trunking.

(iii) In an enclosed trench with removable covers.

(iv) Directly buried in concrete.

NOTES:

1 Table 3(2) contains a reference to the appropriate current-carrying capacity table for enclosed cables installed in air.

2 Where an otherwise unenclosed cable run includes short lengths of wiring enclosure that do not restrict the free circulation of air, the current-carrying capacity for unenclosed conditions may be assigned to the cable run provided that the following are conformed with:

(a) The total enclosed sections do not exceed half the length of the cable run or 6 m, whichever is the shorter dimension.

(b) The wiring enclosure is not surrounded by thermal insulation.

(c) The wiring enclosure is of adequate size to permit free air circulation to dissipate any heat arising from the enclosed cables. This would be satisfied if the wiring enclosure—

(i) has a bore area not less than twice the total cross-sectional area of the enclosed live cables;

(ii) is arranged in a substantially vertical direction; and

(iii) has an open upper end or other means that will not restrict the escape of hot air to the surroundings.

3 Selection of wiring enclosure material needs to take into account the highest sheath temperature of the cable.

3.4.3 Cables installed in thermal insulation

For cables installed in thermal insulation the current-carrying capacities shall be based on the following conditions of installation and operation:

(a) *Ambient temperature* An ambient temperature of the air surrounding the thermal insulation of 30°C.

(b) *Unenclosed cables* Cables installed without further enclosure—

(i) lying on a horizontal surface;

(ii) lying across ceiling joists;

(iii) supported on perforated or unperforated cable trays, ladders, hangers or racks;

(iv) clipped at intervals to a vertical or horizontal surface such as a wall or ceiling joist;

(v) lying in the bottom of open trunking; or

(vi) cables surrounded by bulk-thermal insulation by a distance of less than or equal to 150 mm.

(c) *Enclosed cables* Cables installed in—

(i) metallic or non-metallic wiring enclosure;

(ii) closed trunking or ducts; or

(iii) enclosures surrounded by bulk-thermal insulation by a distance of less than or equal to 150 mm.

(d) *Bulk thermal insulation* Bulk thermal insulation installed as follows:

(i) *Materials* Building materials installed to provide a thermal insulation including—

(A) fibreglass or rockwool batts;

(B) cellulose fibre, paper, cork, seagrass or similar organic materials that are normally installed in a loose-fill form; or

(C) expanded synthetic foams such as polystyrene, ureaformaldehyde or polyurethane, which may be installed by pumping or injection as a wet foam.

NOTE: Reflective foil laminates are not considered to be bulk thermal insulation.

(ii) *Completely surrounded installation* An installation method where bulk thermal insulation totally surrounds, unenclosed or enclosed cables over a length of more than 400 mm.

(iii) *Partially surrounded installation* An installation method where—

(A) bulk thermal insulation is prevented from completely surrounding unenclosed or enclosed cable over a length of more than 150 mm, such as where an unenclosed or enclosed cable is clipped to a structural member or is lying on a ceiling; or

(B) cables totally surrounded by bulk thermal insulation for a distance more than 150 mm but not more than 400 mm shall be considered as a partially surrounded installation.

NOTE: Table 3(2) contains a reference to the appropriate current-carrying capacity table for cables installed in thermal insulation.

3.4.4 Cables buried direct in the ground

For cables buried direct in the ground, the current-carrying capacities shall be based on the following conditions of installation and operation:

(a) *Ambient temperature* An ambient soil temperature of 15°C.

(b) *Depth of laying* A depth of laying of 0.5 m measured from the ground surface to the centre of a cable, or to the centre of a trefoil group of cables.

(c) *Thermal resistivity of soil* A soil thermal resistivity of 1.2°C.m/W.

(d) *Spacing of cables* Cables are spaced as follows:

(i) *Single-core cables* Either—

(A) three single-core cables laid touching throughout in trefoil formation; or

(B) two or three single-core cables laid touching in flat formation.

(ii) *Multicore cables* Multicore cables laid singly.

NOTE: Table 3(3) contains a reference to the appropriate current-carrying capacity table for cables buried direct in the ground. See Clause 3.5.2.5 for spacing distances.

3.4.5 Cables installed in underground wiring enclosures

For cables installed in underground wiring enclosures, the current-carrying capacities shall be based on the following conditions of installation and operation:

(a) *Ambient temperature* An ambient soil temperature of 15°C.

(b) *Depth of laying* A depth of laying of 0.5 m measured from the ground surface to the centre of a wiring enclosure, or to the centre of a trefoil group of wiring enclosures.

(c) *Thermal resistivity of soil* A soil thermal resistivity of 1.2°C.m/W.

(d) *Spacing of wiring enclosures* Wiring enclosures shall be spaced as follows:

  (i) Single-core cables in separate wiring enclosures with—

    (A) two ducts side by side touching; or

    (B) three ducts in trefoil, or in flat formation touching.

  (ii) Single-core cables as a circuit in a single wiring enclosure.

  (iii) Multicore cable in a single wiring enclosure.

NOTES:

1 Table 3(4) contains a reference to the appropriate current-carrying capacity table for cables installed in underground wiring enclosures.

2 See Clause 3.5.2.6 for spacing distances.

3.4.6 Variation of installation conditions along cable run

In situations where one method of installation is used for part of a cable run and other methods for the remainder, the current-carrying capacity of the cable run shall be limited to the lowest value of current determined for each method of installation employed, unless precautions to avoid cable overheating are taken.

NOTES:

1 An example of appropriate precautions is where long runs of cable buried direct in the ground are enclosed in wiring enclosures when passing beneath roadways and the like. The use of selected backfill materials over the enclosed cables can improve the conduction of heat away from the cables and as a consequence higher current-carrying capacities, in the order of that for buried direct cables, can be sustained by the short lengths of enclosed cables.

2 Note 2 to Clause 3.4.2(c) describes a situation where a short length of suitably arranged enclosure may be disregarded for the assignment of a current-carrying capacity to an otherwise unenclosed cable run in air.

3 Attention is drawn to the connection of equipment to an underground cable run by means of short lengths of enclosed or unenclosed cables in air. The current-carrying capacity assigned to the underground portion of the cable run may be assigned to the above-ground portion where the prevailing installation conditions maintain the final operating temperature of the cable within the limits given in Table 1.

4 A short length is defined as a length not greater than 1 m.

3.5 EXTERNAL INFLUENCES ON CABLES

3.5.1 Application of rating factors

The current-carrying capacity of a cable will be affected by the presence of certain external influences as detailed in Clauses 3.5.2 to 3.5.8. Under such conditions the current-carrying capacity given in Tables 4 to 21 shall be corrected by the application of an appropriate rating factor or factors obtained from Tables 22 to 29.

3.5.2 Effect of grouping of cables

3.5.2.1 *General*

The current-carrying capacities given in Tables 4 to 21 relate to single circuits.

Where a number of circuits are installed in the same group in free air, on a surface, buried direct in the ground or within the same sheath or wiring enclosure, in such a way that they are not independently cooled by the ambient air or the ground, the appropriate derating factor shall be as given in Tables 26 to 30.

Specific guidance on the use of Tables 22 to 26 is given in Clauses 3.5.2.3 to 3.5.2.7 and Tables 3(1), 3(2), 3(3) and 3(4).

NOTES:

1 The derating factors have been calculated on the basis of sustained operation of all cables within the group. In most instances the loading on all cables in the group will not occur simultaneously and as a result actual factors may vary from those in Tables 22 to 26. Actual values would need to be calculated according to loading.

2 Where cables of different temperature rating are grouped, they should be rated at the rating appropriate to the lowest temperature cable, unless adequate spacing is provided in accordance with Figure 1.

3.5.2.2 *Installation conditions that avoid derating*

The derating factors of Tables 22 to 26 are not applicable to the following conditions of grouped cables:

(a) *MIMS cables* MIMS cables without serving unless other types of cables are installed in close proximity or within the same wiring enclosure. The higher operating temperature achieved by grouping will not affect the mineral insulation of the unserved cable. However, care should be taken that the cable environment and means of support can withstand the higher temperatures.

NOTE: See Table 1, Note 5.

(b) *Limited length of grouping* Groups of cables such as at a switchboard entry, provided that the length of wiring enclosure does not exceed—

(i) or conductor sizes smaller than 300 mm^2 for aluminium or smaller than 150 mm^2 for copper: 1 m;

(ii) for conductor sizes of 300 mm^2 or larger for aluminium and 150 mm^2 or larger for copper: 3 m; or

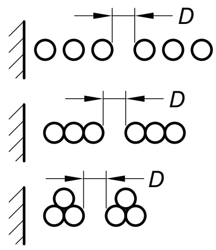
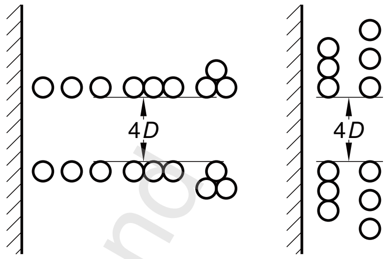
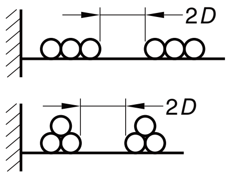
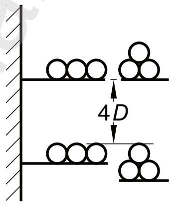
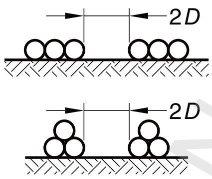
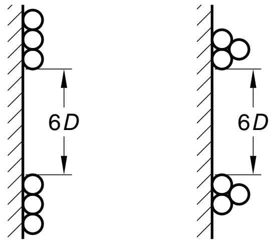
(iii) half the length of the cable.

whichever is the shorter dimension.

(c) *Groups of circuits in free air* Groups of circuits installed unenclosed under the conditions and circuit arrangements depicted in Figure 1.

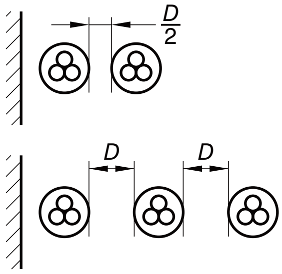
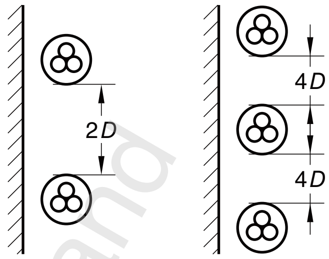
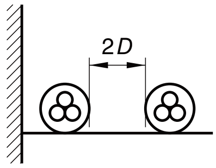
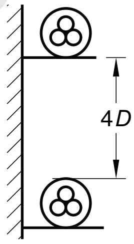
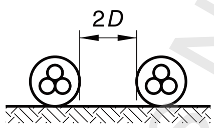
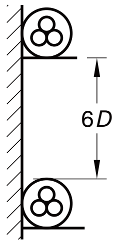
(d) *Cables operating below current-carrying capacity* Cables that, as a result of the conditions of operation of the installation or cable selection practices, are operating at less than 35% of their current-carrying capacity (see Figure 1, Note 3).

NOTE: Circuits comprising two-phase conductors and neutral conductor derived from a three-phase system, are to be treated in the same way as three-phase conductors for the purpose of assigning the current carrying capacity.

Method of installation	Horizontal spacings	Vertical spacings
Cables suspended from a catenary wire where air circulation is unrestricted or spaced from surfaces and supported on ladders, racks, hangers or cleats where the impedance of the air flow around the cable is not greater than 10%		
Cables spaced from surfaces and supported on perforated or unperforated cable trays where air circulation is partially restricted		
Cables fixed directly to a wall, floor, ceiling or similar surface where air circulation is restricted		

(a) Single-core cables

FIGURE 1 (in part) MINIMUM CABLE SPACINGS IN AIR TO AVOID DERATING

<table>
<tr><th>Method of installation</th><th>Horizontal spacings</th><th>Vertical spacings</th></tr>
<tr><td>Cables suspended from a catenary wire where air circulation is unrestricted or spaced from surfaces and supported on ladders, racks, hangers or cleats where the impedance of the air flow around the cable is not greater than 10%</td><td>
</td><td>
</td></tr>
<tr><td>Cables spaced from surfaces and supported on perforated or unperforated cable trays where air circulation is partially restricted</td><td>
</td><td>
</td></tr>
<tr><td>Cables fixed directly to a wall, floor, ceiling or similar surface where air circulation is restricted</td><td>
</td><td>
</td></tr>
</table>

(b) Multicore cables

FIGURE 1 (in part) MINIMUM CABLE SPACINGS IN AIR TO AVOID DERATING

NOTES TO FIGURE 1:

1 *D* equals the cable outside diameter or in the case of a flat multicore cable the maximum dimension of the cable.

2 For simplicity, the illustrations depict balanced multiphase circuits. Where a neutral conductor is required to be substantially loaded, it shall be placed adjacent to the associated active conductors and the clearance measured as appropriate (see Note 3 for lightly loaded or unloaded conductors).

3 The illustrations are intended to depict clearances required between cables operating at or near their sustained current-carrying capacity. Where the loading of any cable is less than 35% of such sustained capacity it may be disregarded from the cable arrangements as its contribution to the mutual heating of the group will be small. Such cables, which would include earthing conductors, lightly loaded neutrals and unloaded control wiring, may be placed adjacent to, or between, groups of associated loaded conductors.

4 Where the cables concerned are not of the same size, the spacing will be based on the largest cable diameter in the adjacent groups.

5 The spacings are essentially minimum requirements to avoid derating and care should be taken, particularly with smaller spacings, to avoid installation methods that would reduce these clearances. No restriction is placed on the number of circuits that may be arranged horizontally with the spacings given. However, care should be taken if more than three circuits are arranged vertically and full cable utilization is required.

6 Where the spacings are not achieved, smaller spacings and derating factors are laid down in the following tables:

(a) For circuits installed directly on walls, floors or ceilings....................Table 22.

(b) For circuits installed on trays, ladder supports, racks, hangers or cleats................ Tables 23 and 24.

7 Proportionally smaller spacings would be acceptable where the cables in the group are not loaded to the full current-carrying capacity. In such cases appropriate rating factors may be obtained from ERA Report 69-30.

3.5.2.3 *Cables run horizontally*

For cables installed horizontally the following shall apply:

(a) *Unenclosed on cable tray, ladder support, rack hanger or cleat* Where a single-core or multicore cable is installed horizontally in close proximity to a cable or cables of another circuit and—

(i) it is on perforated or unperforated trays, ladder supports, racks, hangers or cleats; and

(ii) it is either—

(A) touching the other cable or cables; or

(B) in terms of its spacing from the other cable or cables, less than that specified in Clause 3.5.2.2(c) and Figure 1;

the appropriate derating factor shall be as given in Table 23 or Table 24.

NOTE: An example of the application of these derating factors is provided in Appendix A, Paragraph A4.

(b) *Enclosed, fixed to a surface, or bunched in free air* Where a single-core or multicore cable is installed horizontally in close proximity to a cable or cables of another circuit—

(i) within a wiring enclosure;

NOTE: An example of the application of the derating factors for cables installed in a wiring enclosure is provide in Appendix A, Paragraphs A1 (method A) and A2.

(ii) on a surface, wall, floor or ceiling, spaced or touching;

NOTE: An example of the application of the derating factors for cables installed in a wiring enclosure is provide in Appendix A, Paragraphs A3 and A5 (Conditions B and C).

(iii) bunched in free air; or

NOTE: An example of the application of the derating factors for cables installed in a wiring enclosure is provided in Appendix A, Paragraphs A5 (Condition D).

(iv) suspended from a catenary;

the appropriate derating factor shall be as given in Table 22.

3.5.2.4 *Cables run vertically*

Where a cable is installed vertically, the appropriate current-carrying capacities and derating factors shall be—

(a) obtained from Tables 22 to 24 as for cables run horizontally; and

(b) determined in accordance with Clause 3.5.3 using the highest ambient air temperature up the cable run, if a barrier is not provided at intervals of 3.5 m or less that prevents the vertical flow of air along the cable.

3.5.2.5 *Cables buried direct in the ground*

Where a single-core or multicore cable is buried directly in the ground and is separated by not less than 2 m from a cable or cables of another circuit carrying substantial currents, no derating factor need be applied. Where the circuits are separated by less than 2 m, the appropriate derating factor shall be obtained from Tables 25(1) and 25(2), for installation methods not covered in this Standard, alternative specifications as recommended in Clause 1.3.

NOTES:

1 The derating factors have been determined from the hottest cable in the group and assume that all cables are of the same thermal grade of insulation.

2 An example of the application of these derating factors is provided in Appendix A, Paragraph A1 (method D).

3.5.2.6 *Cables in wiring enclosures*

For cables in enclosures the following shall apply:

(a) *Underground wiring enclosures* Where a single-core or multicore cable is installed in an underground wiring enclosure and is separated by not less than 2 m from a cable or cables of another enclosed circuit carrying substantial currents, no derating factor need be applied. Where the enclosed circuits are separated by less than 2 m, the appropriate derating factor shall be as given in Tables 26(1) and 26(2) or, for installation methods not covered in this Standard, alternative specifications as recommended in Clause 1.3.

NOTE: An example of the application of these derating factors is provided in Appendix A, Paragraph A1 (methods B and C).

(b) *Other enclosures* Where cables are installed in an enclosure such as a switchboard, the current-carrying capacity shall be determined from the unenclosed in air conditions in Tables 4 to 10 with due regard being given to the derating factors when circuits are bunched.

NOTE: The selection of the derating factor should be based on the number of circuits that would be loaded; for example, where nine circuits are bunched but only six are loaded at any one time, a derating factor of 0.57 from Table 22 would be applicable.

3.5.2.7 *Conductors connected in parallel or passing more than once within a group or enclosure*

In applying the derating factors of Tables 22 to 26 where—

(a) a group of conductors forming a circuit passes more than once through the same wiring enclosure, group of cables or group of enclosures; or

(b) groups of conductors are connected in parallel,

each separate group of conductors shall be regarded as a separate circuit.

3.5.2.8 *Cables on drums or reels*

Where layers of flexible cables are wound on a cylindrical-type drum or reel, the current-carrying capacity of the cable shall be derated by the appropriate factor, as follows:

Number of layers	1	2	3	4
Derating factor	0.85	0.65	0.45	0.35

Where a single spiral layer of flexible cable is accommodated on a radial-type drum, the current-carrying capacity of the cable shall be derated by a factor of 0.85 for ventilated drums and 0.75 for unventilated drums.

3.5.3 Effect of ambient temperature

The current-carrying capacities given in the Tables of this Standard are based on a consistent ambient air temperature of 30°C and an ambient soil temperature of 15°C. Where other ambient temperatures apply, the appropriate rating factors shall be as given in Tables 27(1) and 27(2).

NOTES:

1 In Australia the conditions of installation specify an ambient temperature of 40°C and a soil temperature of 25°C. A complete set of current rating tables, calculated for Australian conditions, is given in AS/NZS 3008.1.1.

2 Particular consideration should be given to the existence of higher ambient air temperatures in confined roof spaces, boiler rooms, cable tunnels, vertical shafts and the like. Similarly, lower ambient temperatures may apply for cables installed in concrete slabs on or above the surface of the ground.

3 In practice the ambient air temperature may be measured by one of the following simple methods:

(a) *Before installation of cables* Measurement may be made by temperature sensors placed in free air as close as practicable to the position at which the cables are to be installed.

(b) *After installation of cables* Measurement may be made by temperature sensors placed in free air in the vicinity of the cables in such a position that readings are not influenced by heat arising from the cables. Where the measurements are made while the cables are loaded, e.g. as may be required by Clause 3.5.2.4 for vertical cable runs, the sensors should be placed approximately 500 mm, or 10 times the overall diameter of the cable, from the cables in a horizontal plane, or 150 mm below the cables.

4 An example of the application of these derating factors is provided in Appendix A, Paragraph A3.

If at the cable position, the ambient temperature, including any increase of temperature due to heat arising from equipment to which the cables are connected, does not exceed 30°C except for infrequent combinations of weather and load currents, then the current-carrying capacities given in the Tables apply without correction.

3.5.4 Effect of depth of laying

The current-carrying capacities given in the Tables of this Standard are based on a depth of laying of 0.5 m as specified in Clauses 3.4.4 and 3.4.5. Where other depths of laying apply, the appropriate rating factors shall be as given in Tables 28(1) and 28(2).

NOTE: The rating factors are based on the assumption that the effective thermal resistivity of the ground is constant from a depth of 0.5 m to 3 m. Above and below these respective limits it is considered that a reduction in effective thermal resistivity occurs due to the composition and moisture content of the soil.

3.5.5 Effect of thermal resistivity of soil

The current-carrying capacities given in the Tables of this Standard are based on a soil thermal resistivity of 1.2°C.m/W.

Soil thermal resistivity varies greatly with soil composition, moisture retention qualities and seasonal weather patterns as well as the variation in load carried by the cable. Higher current-carrying capacities are obtained in clay or peat soils, which may have resistivities as low as 0.8°C.m/W. Similarly, values as high as 2.5°C.m/W may be associated with well drained sands for constantly loaded cables. The value of 1.2°C.m/W has been selected as an average figure on the basis of soil types and assumes maximum thermal resistivity at times of maximum load.

If possible the actual value should be measured along the cable route as it can greatly affect the current-carrying capacity of the cable. Where values for soil resistivities other than 1.2°C.m/W apply, the appropriate rating factors may be obtained from Table 29.

NOTE: Where the soil is known to be of poor quality and has a thermal resistivity greater than 1.2°C.m/W throughout much of the year, consideration should be given to the use of a selected or stabilized backfill material around the cables or wiring enclosures.

Such backfill should completely surround the cable with a minimum thickness of 200 mm and could be used in lieu of the bedding required in AS/NZS 3000.

The following two types of material have a worst-case or dried-out thermal resistivity in the order of 1.2°C.m/W:

(a) *Cement-bound sand* A mixture of sand bound with cement in the ratio of 14:1 by volume, with water added to enable adequate compaction to be achieved.

(b) *Gravel/sand* A mixture of a selected sand having a dried-out thermal resistivity of not greater than 2.7°C.m/W, with an equal quantity of 10 mm coarse aggregate.

3.5.6 Effect of varying loads

The current-carrying capacities given in the Tables of this Standard and the derating factors given in Clauses 3.5.2 to 3.5.5 are based on continuous loading on all conductors. Where it can be shown that intermittent load variations will occur or that all conductors cannot be loaded simultaneously, appropriate uprating factors may be applied.

In many installations, groups of cables comprise a mixture of loaded and unloaded cables at any one time and the designer may justify the use of alternative derating factors to those specified in Tables 22 to 26, if the connected loads have a known diversity. If the diversity is unknown or unobtainable by experiment, the design may have to be based on worst-case analysis of the possible load combinations at any one time. Some information on the diversity of certain loads may be obtained from the determination of maximum demand in AS/NZS 3000.

3.5.7 Effect of thermal insulation

Current-carrying capacities are given in Tables 4 to 15 of this Standard for unenclosed or enclosed cables surrounded by bulk thermal insulating materials that affect the rate of heat dissipation from the cables.

The rate of heat dissipation varies with the type and thickness of material used. A comparative measure of the performance of different materials is known as the R-factor.

The current-carrying capacity values in the Tables are based upon typical installation conditions and a range of different materials as described in Clause 3.4.3. Where different materials or installation conditions are used such that the rate of heat dissipation is adversely or favourably affected, lower or higher current-carrying capacities may be obtained respectively.

NOTES:

1 Where a length of cable not exceeding 150 mm passes through bulk thermal insulation, e.g. for the connection of a lighting point, the cable need not be considered as being surrounded by thermal insulation.

2 A cable is considered to be affected by thermal insulation if it is embedded in, or surrounded by, insulating material. Cables lying on top of suitably rigid material do not in general come into this consideration.

3.5.8 Effect of direct sunlight

Current-carrying capacities are given in Tables 4 to 15, 20 and 21 for cables exposed to direct sunlight. For other types of cable installed in locations exposed to direct solar radiation it will be necessary to make some provision for the effects of the increased heating. This may be achieved by one of the following means:

(a) Provision of a shield, screen or enclosure that allows for the natural ventilation of the cable.

(b) Reduction of the current-carrying capacity of the cable by an appropriate amount in accordance with the higher air temperature. As a rule-of-thumb alternative to any recommendation from a cable manufacturer, a correction factor obtained from Table 27(1) for a temperature 20° higher than the ambient air temperature may be applied.

NOTE: For further information on the effects of ultraviolet radiation, it is recommended that the cable manufacturer be consulted.

3.5.9 Effect of harmonic currents on balanced three-phase systems

Where the neutral conductor carries current without a corresponding reduction in load of the phase conductors, the current flowing in the neutral conductor shall be taken into account in ascertaining the current-carrying capacity of the circuit.

This Clause is intended to cover the situation where there is current flowing in the neutral of a balanced three-phase system. Such neutral currents are due to the line currents having a harmonic content that does not cancel in the neutral. The most significant harmonic that does not cancel in the neutral is usually the third harmonic. The magnitude of the neutral current due to the third harmonic may exceed the magnitude of the power frequency phase current. The neutral current will then have a significant effect on the current-carrying capacity of the cables in the circuit.

The reduction factors given in this Clause apply to balanced three-phase circuits; it is recognized that the situation is more onerous if only two of the three phases are loaded. In this situation the neutral conductor will carry the harmonic currents in addition to the unbalanced current. Such a situation can lead to overloading of the neutral conductor.

Equipment likely to cause significant harmonic currents are, for example, fluorescent lighting banks and d.c. power supplies such as those found in computers.

The reduction factors given in Table 2 only apply to cables where the neutral conductor is within a four- or five-core cable and is of the same material and cross-sectional area as the phase conductors. These reduction factors have been calculated based on third harmonic currents. If significant, more than 10%, higher harmonics, 9th, 12th, etc. are expected then lower reduction factors are applicable. Where there is an unbalance between phases of more than 50% then lower reduction factors may be applicable.

The tabulated reduction factors, when applied to the current-carrying capacity of a cable with three loaded conductors, will give the current-carrying capacity of a cable with four loaded conductors where the current in the fourth conductor is due to harmonics. The reduction factors also take the heating effect of the harmonic current in the phase conductors into account.

Where the neutral current is expected to be higher than the phase current then the cable size should be selected on the basis of the neutral current.

Where the cable size selection is based on a neutral current that is not significantly higher than the phase current, it is necessary to reduce the tabulated current-carrying capacity for three loaded conductors.

If the neutral current is more than 135% of the phase current and the cable size is selected on the basis of the neutral current then the three-phase conductors will not be fully loaded. The reduction in heat generated by the phase conductors offsets the heat generated by the neutral conductor to the extent that it is not necessary to apply any reduction factor to the current-carrying capacity for three loaded conductors.

TABLE 2

REDUCTION FACTORS FOR HARMONIC CURRENTS IN 4- AND 5-CORE CABLES

Third harmonic content of phase current %	Reduction factor	
	Size selection is based on phase current	Size selection is based on neutral current
0–15	1.0	—
15–33	0.86	—
33–45	—	0.86
> 45	—	1.0

NOTE: Examples of the application of reduction factors for harmonic currents are provided in Appendix C.

3.5.10 Effect of parallel cables

Current-carrying capacities for circuits comprising parallel multicore cables or groups of single-core cables can be determined from the sum of the current-carrying capacity of the various cables provided that consideration is given to—

(a) grouping cables and the effect of cooling by the ambient air or the ground on each parallel cable or group; and

(b) load current sharing between each parallel cable or group so as to prevent overheating of any cable or group.

Equal load current sharing is generally achieved by the selection and installation of cables to give the same impedance, i.e. by using cables of the same conductor material and construction installed over the same route. Mutual impedance is also affected by the configuration of cables within and between each group.

NOTES:

1 Table D1 of Appendix D provides recommended circuit configurations parallel single-core cables for load current sharing considerations. The preferred circuit configuration is to use trefoil groups containing each of the three-phase conductors and neutral in each group.

2 Unequal load current sharing between cables or groups may be permitted provided that the design current and overcurrent protection requirements for each cable or group are considered individually. IEC 60364-4-43 provides further information on the conditions under which this is permitted.

3.5.11 Effect of electromagnetic interference

Certain types of electrical installations, e.g. those containing sensitive electronic equipment or systems, may require minimization of electromagnetic interference arising from magnetic fields developed from current flowing in cables. This may be addressed by—

(a) selection of cables designed for low magnetic field emissions; or

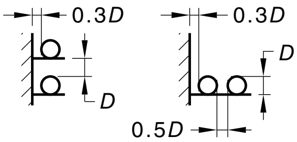
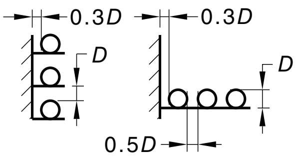
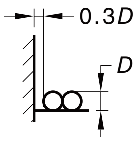
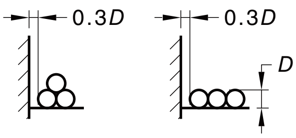
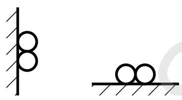
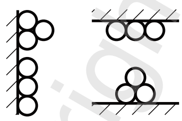
(b) installation of cables in enclosures that contain or shield magnetic fields; or

(c) installation of cables in configurations that produce low magnetic fields.

NOTE: Table D2 of Appendix D provides recommended circuit configurations for the installation of parallel single-core cables in groups that produce reduced levels of magnetic field.

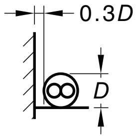
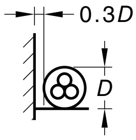
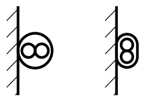
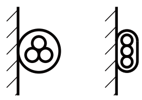
TABLE 3(1)

SCHEDULE OF INSTALLATION METHODS FOR CABLES DEEMED TO HAVE THE SAME CURRENT-CARRYING CAPACITY AND CROSS-REFERENCES TO APPLICABLE DERATING TABLES—UNENCLOSED IN AIR

1	2	3	4	5	6
Item No.	**Cable details (see Note 2)**	**Reference drawing (see Note 3)**	**Current-carrying capacity table reference**	**Methods of installation for cables deemed to have the same current-carrying capacity (see Notes 4, 5 and 6)**	**Derating table**
1	Two single-core cables		Tables 4 and 5 Columns 2 to 4 Table 6 Columns 2 and 3	Cables with minimum cable separation in air as shown for horizontal and vertical mounting and installed— (a) spaced from a wall or vertical surface; (b) supported on ladders, racks, perforated trays, cleats or hanger; or (c) suspended from a catenary wire.	23
2	Three single-core cables		Tables 7 and 8 Columns 2 to 4 Table 9 Columns 2 and 3		
3					22
4	Two single-core cables		Tables 4 and 5 (see Note 5) Columns 5 to 7 Table 6 Columns 2 and 3	Cables with minimum cable spacings in air as shown and installed— (a) spaced from a wall or vertical surface; (b) supported on ladders, racks, perforated or unperforated trays, cleats or hangers; (c) in a switchboard or similar enclosure; or (d) suspended from a catenary wire.	23
5	Three single-core cables		Tables 7 and 8 (see Note 5) Columns 5 to 7 Table 9 Columns 4 and 5		
6					22
7	Two single-core cables		Tables 4 and 5 (see Note 4) Columns 8 to 10 Table 6 Columns 6 and 7	Cables of the one circuit touching and installed— (a) clipped direct to a wall, floor, ceiling or similar surface; (b) in a ventilated trench or open trunking; (c) buried directly in a plaster or render on a wall; or (d) in a switchboard or similar enclosure.	22
8	Three single-core cables		Tables 7 and 8 (see Note 4) Columns 8 to 10 Table 9 Columns 6 and 7		

(*continued*)

TABLE 3(1) *(continued)*

1	2	3	4	5	6
Item No.	**Cable details (see Note 2)**	**Reference drawing (see Note 3)**	**Current-carrying capacity table reference**	**Methods of installation for cables deemed to have the same current-carrying capacity (see Notes 4, 5 and 6)**	**Derating table**
9	Two-core cables		Tables 10 and 11 (see Note 5) Columns 2 to 4 Table 12 Columns 2 and 3	Cables with minimum spacings in air as shown and installed— (a) spaced from a wall or vertical surface; (b) supported on ladders, racks, perforated or unperforated trays, cleats or hangers; (c) in a switchboard or similar enclosure; or (d) suspended from a catenary or as a self-supported overhead cable.	24
10	Three-core cables		Tables 13 and 14 (see Note 5) Columns 2 to 4 Table 15 Columns 2 and 3		
11					22
12	Two-core cables		Tables 10 and 11 (see Note 4) Columns 5 to 7 Table 12 Columns 4 and 5	Cables installed— (a) clipped direct to a wall, floor, ceiling or similar surface; (b) buried directly in concrete or masonry above the ground or in plaster or render on a wall; (c) in a ventilated trench or open trunking; or (d) in a switchboard or similar enclosure	22
13	Three-core cables		Tables 13 and 14 (see Note 4) Columns 5 to 7 Table 15 Columns 4 and 5		

NOTES:

1 *D* equals the cable outside diameter or in the case of a flat multicore cable the maximum dimension of the cable.

2 Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be counted in the number of cable cores.

3 See column headings of Tables 4 to 15.

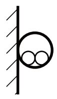
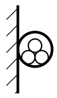
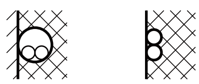
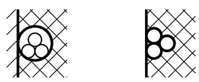
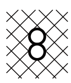
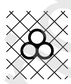
4 See Table 22 for the derating factor applicable to a single circuit fixed to the underside of a ceiling or similar horizontal surface.

5 See Tables 23 and 24 for the derating factors applicable to a single circuit fixed to perforated or unperforated trays.

6 See AS/NZS 3000 for the restricted installation conditions of certain types of cable, e.g. unarmoured cables in plaster or cement render on walls.

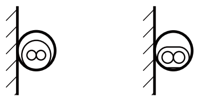
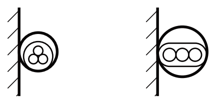
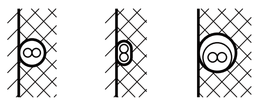
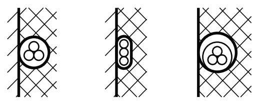
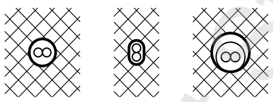
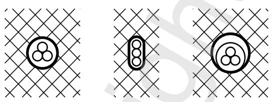
TABLE 3(2)

SCHEDULE OF INSTALLATION METHODS FOR CABLES DEEMED TO HAVE THE SAME CURRENT-CARRYING CAPACITY AND CROSS-REFERENCES TO APPLICABLE DERATING TABLES—ENCLOSED

1	2	3	4	5	6
Item No.	**Cable details (see Note 1)**	**Reference drawing (see Note 2)**	**Current-carrying capacity table reference**	**Methods of installation for cables deemed to have the same current-carrying capacity (see Note 3)**	**Derating table**
1	Two single-core cables		Tables 4 and 5 Columns 15 to 17 Table 6 Columns 11 and 12	Cables in wiring enclosures installed in— (a) air; (b) plaster, cement render, masonry or concrete in a wall or floor; (c) a concrete slab on or above the surface of the ground; or (d) a ventilated trench. Cables installed in— (a) a wiring enclosure on a wall; or (b) an enclosed trench with a removable cover.	22
2	Three single-core cables		Tables 7 and 8 Columns 15 to 17 Table 9 Columns 11 and 12		
3	Two single-core cables		Tables 4 and 5 Columns 18 and 19 Table 6 Column 13	Cables enclosed or unenclosed— (a) partially surrounded by thermal insulation material; or (b) in an enclosed trench.	22
4	Three single-core cables		Tables 7 and 8 Columns 18 and 19 Table 9 Column 13		
5	Two single-core cables		Tables 4 and 5 Columns 20 and 21 Table 6 Column 14	Unenclosed cables completely surrounded by thermal insulation.	22
6	Three single-core cables		Tables 7 and 8 Columns 20 and 21 Table 9 Column 14		

(continued)

TABLE 3(2) (*continued*)

1	2	3	4	5	6
Item No.	**Cable details (see Note 1)**	**Reference drawing (see Note 2)**	**Current-carrying capacity table reference**	**Methods of installation for cables deemed to have the same current-carrying capacity (see Note 3)**	**Derating table**
7	Two-core cables		Tables 10 and 11 Columns 11 to 13 Table 12 Columns 9 and 10	Cables in wiring enclosures installed in— (a) air; (b) plaster, cement render, masonry or concrete in a wall or floor; (c) a concrete slab on or above the surface of the ground; or (d) a ventilated trench. Cables installed in— (a) closed trunking, or wiring enclosures on a wall; or (b) an enclosed trench with a removable cover.	22
8	Three-core cables		Tables 13 and 14 Columns 11 to 13 Table 15 Columns 9 and 10		
9	Two-core cables		Tables 10 and 11 Columns 15 to 18 Table 12 Column 11	Enclosed or unenclosed cables partially surrounded by thermal insulation.	22
10	Three-core cables		Tables 13 and 14 Columns 15 to 18 Table 15 Column 11		
11	Two-core cables		Tables 10 and 11 Columns 19 to 22 Table 12 Column 12	Enclosed or unenclosed cables completely surrounded by thermal insulation.	22
12	Three-core cables		Tables 13 and 14 Columns 19 to 22 Table 15 Column 12		

NOTES:

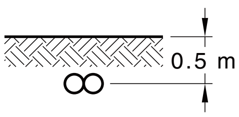
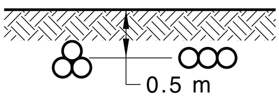
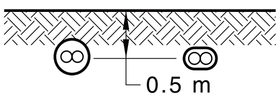
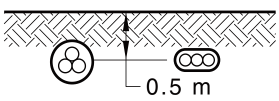
1 Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be counted in the number of cable cores.

2 See column headings of Tables 4 to 15.

3 See AS/NZS 3000 for the restricted installation conditions of certain types of cables, e.g. insulated or insulated and sheathed cables in metallic and non-metallic conduits.

TABLE 3(3)

SCHEDULE OF INSTALLATION METHODS FOR CABLES DEEMED TO HAVE THE SAME CURRENT-CARRYING CAPACITY AND CROSS-REFERENCES TO APPLICABLE DERATING TABLES—BURIED DIRECT IN THE GROUND

1	2	3	4	5	6
Item No.	**Cable details (see Note 1)**	**Reference drawing (see Note 2)**	**Current-carrying capacity table reference**	**Methods of installation for cables deemed to have the same current-carrying capacity (see Note 3)**	**Derating table**
1	Two single-core cables		Tables 4 and 5 Columns 22 and 23 Table 6 Column 15	Cables with a minimum depth of laying of— (a) 0.3 m under continuous concrete paved areas; or (b) 0.5 m in other locations.	25(1)
2	Three single-core cables		Tables 7 and 8 Columns 22 and 23 Table 9 Column 15		
3	Two-core cables		Tables 10 and 11 Columns 23 and 24 Table 12 Column 13		25(2)
4	Three-core cables		Tables 13 and 14 Columns 23 and 24 Table 15 Column 13		

NOTES:

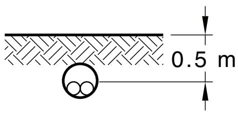
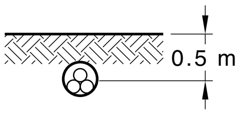
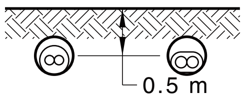
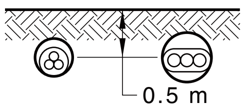
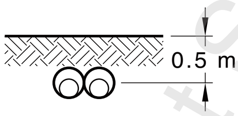
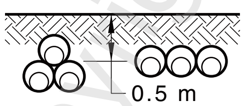
1 Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be counted in the number of cable cores.

2 See column headings of Tables 4 to 15.

3 See Tables 27(1), 27(2), 28(1) and 28(2) for rating factors applicable to different ambient soil temperatures and depths of laying.

TABLE 3(4)

SCHEDULE OF INSTALLATION METHODS FOR CABLES DEEMED TO HAVE THE SAME CURRENT-CARRYING CAPACITY AND CROSS-REFERENCES TO APPLICABLE DERATING TABLES—UNDERGROUND WIRING ENCLOSURES

1	2	3	4	5	6	
					Derating table	
Item No.	**Cable details (see Note 1)**	**Reference drawing (see Note 2)**	**Current-carrying capacity table reference**	**Methods of installation for cables deemed to have the same current-carrying capacity (see Note 3)**	**More than one circuit in same enclosure**	**More than one circuit in separate enclosures**
1	Two single-core cables		Tables 4 and 5 Columns 24 to 26 Table 6 Columns 16 and 17	Cables in a single enclosure laid— (a) a minimum of 0.3 m below continuous concrete paved areas; or (b) minimum 0.5 m in other locations.	22	26(2)
2	Three single-core cables		Tables 7 and 8 Columns 24 to 26 Table 9 Columns 16 and 17			
3	One two-core cable		Tables 10 and 11 Columns 25 to 27 Table 12 Columns 14 and 15			
4	One three-core cable		Tables 13 and 14 Columns 25 to 27 Table 15 Column 14 and 15			
5	Single-core cables		Tables 4 and 5 Columns 27 and 28 Table 6 Column 18	Two enclosures laid— (a) directly under continuous concrete paved areas; or (b) minimum 0.5 m in other locations.		26(1)
6			Tables 7 and 8 Columns 27 and 28 Table 9 Column 18	Three enclosures laid— (a) directly under continuous concrete paved areas; or (b) minimum 0.5 m in other locations.		

NOTES:

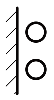
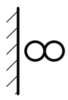
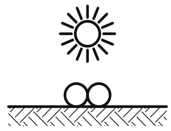
1 Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be counted in the number of cable cores.

2 See column headings of Tables 4 to 15.

3 See Tables 27(1), 27(2), 28(1) and 28(2) for rating factors applicable to different ambient soil temperatures and depths of laying.

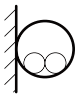
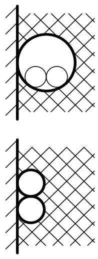
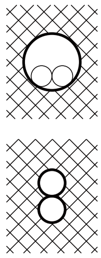
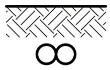
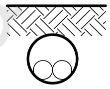
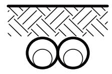
TABLE 4
CURRENT-CARRYING CAPACITIES

CABLE TYPE:	**TWO SINGLE-CORE (See Note 1)**
INSULATION TYPE:	**THERMOPLASTIC (See Note 2)**
MAXIMUM CONDUCTOR TEMPERATURE:	**75°C**
REFERENCE AMBIENT TEMPERATURE:	**30°C IN AIR, 15°C IN GROUND**

1	2	3	4	5	6	7	8	9	10	11	12	13
Conductor size	Current-carrying capacity, A											
	Unenclosed											
	Spaced			Spaced from surface			Touching			Exposed to sun		
												
	Cu		Al	Cu		Al	Cu		Al	Cu		Al
mm^2	Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible	
1	18	19	—	18	19	—	15	15	—	9	9	—
1.5	24	24	—	24	24	—	18	19	—	11	11	—
2.5	34	33	—	33	32	—	26	25	—	15	15	—
4	46	43	—	44	43	—	35	34	—	21	19	—
6	58	56	—	56	55	—	46	43	—	25	24	—
10	79	79	—	76	76	—	62	62	—	34	33	—
16	105	104	82	101	100	79	82	81	64	44	43	34
25	141	138	109	136	131	105	111	107	86	57	56	44
35	174	171	136	165	163	129	136	133	105	70	67	54
50	213	215	165	202	204	156	166	168	129	82	83	64
70	271	271	210	254	255	197	210	211	163	101	101	79
95	336	327	261	315	307	244	262	254	203	122	119	95
120	392	389	304	366	361	284	304	302	237	139	137	108
150	450	448	350	418	416	325	351	349	272	156	154	121
185	523	513	407	483	474	377	408	400	318	176	171	137
240	626	617	487	576	568	449	488	481	381	202	197	157
300	725	711	564	663	651	520	564	554	442	226	219	177
400	848	857	665	771	777	610	658	665	520	252	249	200
500	988	999	781	889	897	711	762	770	610	279	274	223
630	1156	1181	921	1023	1042	832	878	895	715	307	303	250

(continued)

TABLE 4 (*continued*)

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Conductor size	Current-carrying capacity, A													
	Enclosed			Thermal insulation				Buried direct		Underground wiring enclosure				
	Wiring enclosure in air			Partially surrounded by thermal insulation		Completely surrounded by thermal insulation								
														
	Cu		Al	Cu	Al	Cu	Al	Cu	Al	Cu		Al	Cu	Al
mm²	Solid/ Stranded	Flexible								Solid/ Stranded	Flexible			
1	15	16	—	13	—	7	—	24	—	20	21	—	23	—
1.5	21	21	—	16	—	9	—	31	—	25	25	—	29	—
2.5	27	27	—	23	—	14	—	43	—	35	34	—	40	—
4	36	35	—	29	—	18	—	56	—	45	44	—	52	—
6	47	46	—	38	—	23	—	71	—	57	55	—	64	—
10	62	62	—	50	—	31	—	94	—	76	75	—	85	—
16	80	79	62	64	49	41	32	134	105	98	96	76	109	85
25	107	104	83	86	66	55	42	174	135	128	123	99	142	110
35	128	125	99	103	80	67	52	209	162	153	150	119	171	132
50	157	158	122	125	98	—	—	248	191	185	185	143	205	160
70	194	193	150	155	120	—	—	305	237	227	226	176	251	195
95	242	235	187	193	149	—	—	365	283	277	268	215	306	237
120	276	270	214	220	171	—	—	416	323	316	310	245	348	270
150	321	317	250	257	200	—	—	466	362	362	356	281	389	301
185	365	356	284	292	227	—	—	528	411	410	399	320	449	349
240	434	425	340	348	271	—	—	612	477	482	472	376	519	405
300	—	—	—	—	—	—	—	691	540	546	542	427	601	468
400	—	—	—	—	—	—	—	784	620	633	629	499	683	536
500	—	—	—	—	—	—	—	886	708	714	729	572	793	627
630	—	—	—	—	—	—	—	994	811	825	829	672	898	717

NOTES TO TABLE 4:

1 Applies to non-armoured, sheathed or unsheathed cables.

2 The normal operating temperature of thermoplastic cables, including flexible cords installed as installation wiring, are based on a conductor temperature of 75°C. This is due to the risk of thermal deformation of insulation if the cables are clipped, fixed or otherwise installed in a manner which exposes the cable to severe mechanical pressure at higher temperatures.

V-90 and V-90HT insulated cables may be operated up to the maximum permissible temperatures 90°C and 105°C provided that the cable is installed in a manner that is not subject to, or is protected against, severe mechanical pressure at temperatures higher than 75°C. Such applications also allow for cables to be used in—

(a) locations where the ambient temperature exceeds the normal 30°C, e.g. equipment wiring in luminaires and heating appliances, or in roof spaces affected by high summer temperatures; and

(b) locations affected by bulk thermal insulation that restricts the dissipation of heat from the cable.

3 See Tables 3(1), 3(2), 3(3) and 3(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.

4 Derating factors may apply as follows:

(a) The current-carrying capacities apply to single circuits. For grouped cable circuits, see Clause 3.5.2 and Tables 22, 23, 25(1), 25(2), 26(1) and 26(2) for appropriate derating factors.

(b) For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 8 to 10.

(c) For a single circuit fixed to perforated or unperforated cable tray, see Table 23 for the derating factor to be applied to the current-carrying capacities given in Columns 5 to 7.

(d) For ambient temperature and depth of laying factors, see Tables 27(1), 27(2), 28(1) and 28(2).

5 To calculate the single-phase voltage drop of these configurations, multiply the appropriate three-phase voltage drop value in Table 40, Table 43 or Table 46 by 1.155.

6 These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

7 For conductor sizes up to 10 mm^2 in Column 22 the values are based on ratings for wiring in underground wiring enclosures.

8 Cables within the scope of AS/NZS 5000.2 (up to 16 mm^2) may be rated to the values in the Tables covering 90°C insulated cables, subject to—

(a) information provided in Note 2; and

(b) any other relevant requirements of AS/NZS 3000.

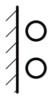
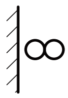
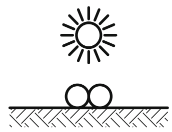
TABLE 5
CURRENT-CARRYING CAPACITIES

CABLE TYPE: TWO SINGLE-CORE (See Note 1)

INSULATION TYPES: X-90, X-HF-90, R-EP-90, R-CPE-90, R-HF-90 OR R-CSP-90

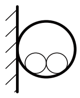
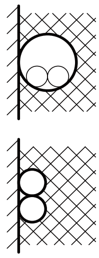
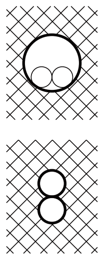
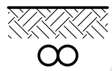
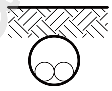
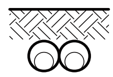
MAXIMUM CONDUCTOR TEMPERATURE: 90°C (See Note 2)

REFERENCE AMBIENT TEMPERATURE: 30°C IN AIR, 15°C IN GROUND

1	2	3	4	5	6	7	8	9	10	11	12	13
Conductor size	Current-carrying capacity, A											
	Unenclosed											
	Spaced			Spaced from surface			Touching			Exposed to sun		
												
	Cu			Cu			Cu			Cu		
mm^2	Solid/ Stranded	Flexible	Al	Solid/ Stranded	Flexible	Al	Solid/ Stranded	Flexible	Al	Solid/ Stranded	Flexible	Al
1	22	23	—	22	23	—	18	18	—	13	14	—
1.5	29	29	—	28	29	—	22	22	—	17	18	—
2.5	40	39	—	40	37	—	31	30	—	23	23	—
4	53	51	—	52	51	—	41	40	—	31	30	—
6	67	65	—	66	64	—	52	51	—	40	37	—
10	92	91	—	90	89	—	72	70	—	53	53	—
16	123	121	96	119	117	92	95	94	74	70	69	55
25	166	162	129	160	155	123	129	125	100	95	91	73
35	205	201	158	195	191	151	158	155	122	116	113	89
50	251	254	195	238	240	184	194	196	150	140	141	109
70	320	321	249	300	301	233	246	248	191	176	177	136
95	397	386	308	372	361	288	306	298	238	217	211	168
120	464	460	361	432	428	336	358	354	278	252	249	196
150	535	531	415	496	493	385	413	410	320	288	286	224
185	622	611	483	574	563	447	480	471	374	333	326	260
240	746	735	580	684	674	534	574	567	449	395	388	308
300	866	849	673	790	776	618	666	653	520	454	444	355
400	1015	1026	795	920	927	726	779	787	615	526	528	415
500	1186	1199	935	1063	1073	849	903	913	722	605	607	483
630	1387	1417	1103	1224	1249	994	1045	1066	849	692	703	562

(*continued*)

TABLE 5 (*continued*)

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Conductor size	Current-carrying capacity, A													
	Enclosed			Thermal insulation				Buried direct		Underground wiring enclosure				
	Wiring enclosure in air			Partially surrounded by thermal insulation		Completely surrounded by thermal insulation								
														
	Cu		Al	Cu	Al	Cu	Al	Cu	Al	Cu		Al	Cu	Al
mm^2	Solid/ Stranded	Flexible								Solid/ Stranded	Flexible			
1	18	19	—	14	—	9	—	21	—	21	22	—	26	—
1.5	23	23	—	18	—	11	—	28	—	28	28	—	32	—
2.5	33	31	—	26	—	15	—	39	—	39	37	—	44	—
4	42	41	—	33	—	21	—	49	—	49	48	—	57	—
6	52	51	—	42	—	26	—	62	—	62	60	—	71	—
10	72	70	—	57	—	35	—	83	—	83	82	—	93	—
16	92	90	72	74	57	47	36	149	114	107	105	83	120	93
25	124	120	96	99	77	64	50	192	149	140	136	109	156	122
35	149	145	116	119	92	79	62	230	179	168	165	131	187	146
50	183	184	142	146	113	—	—	273	212	202	203	157	226	175
70	224	224	175	180	140	—	—	335	260	249	248	194	276	214
95	281	273	218	224	174	—	—	401	311	305	295	236	331	256
120	321	315	249	256	199	—	—	457	355	348	341	270	383	297
150	362	370	281	289	224	—	—	514	398	391	394	303	429	333
185	426	415	331	340	265	—	—	581	453	453	441	352	495	384
240	507	497	396	406	317	—	—	674	526	532	520	415	574	446
300	—	—	—	—	—	—	—	761	595	601	586	471	663	516
400	—	—	—	—	—	—	—	865	683	699	696	552	755	592
500	—	—	—	—	—	—	—	977	780	791	784	631	856	676
630	—	—	—	—	—	—	—	1098	891	916	920	744	995	792

NOTES TO TABLE 5:

1 Applies to non-armoured, sheathed or unsheathed cables.

2 The normal operating temperature of thermoplastic cables, including flexible cords installed as installation wiring, is based on a conductor temperature of 75°C. This is due to the risk of thermal deformation of insulation if the cables are clipped, fixed or otherwise installed in a manner that exposes the cable to severe mechanical pressure at higher temperatures.

V-90 and V-90HT insulated cables may be operated up to the maximum permissible temperatures 90°C and 105°C provided that the cable is installed in a manner that is not subject to, or is protected against, severe mechanical pressure at temperatures higher than 75°C. Such applications also allow for cables to be used in—

(a) locations where the ambient temperatures exceed the normal 30°C, e.g. equipment wiring in luminaires and heating appliances, or in roof spaces affected by high summer temperatures; and

(b) locations affected by bulk thermal insulation that restricts the dissipation of heat from the cable.

3 For cables with a maximum conductor temperature of 105°C the applicable current ratings are those provided for copper conductors up to and including $10mm^2$ size.

4 See Tables 3(1), 3(2), 3(3) and 3(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.

5 Derating factors may apply as follows:

(a) The current-carrying capacities apply to single circuits. For grouped cable circuits, see Clause 3.5.2 and Tables 22, 23, 25(1), 25(2), 26(1) and 26(2) for appropriate derating factors.

(b) For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 8 to 10.

(c) For a single circuit fixed to perforated or unperforated cable tray, see Table 23 for the derating factor to be applied to the current-carrying capacities given in Columns 5 to 7.

(d) For ambient temperature and depth of laying factors, see Tables 27(1), 27(2), 28(1) and 28(2).

6 To calculate the single-phase voltage drop of these configurations, multiply the appropriate three-phase voltage drop value in Table 40 or Table 43 by 1.155.

7 These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

For conductor sizes up to 10 mm^2 in Column 22, the values are based on ratings for wiring in underground wiring enclosures.

TABLE 6

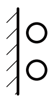
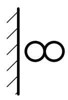
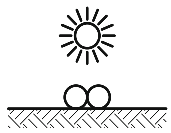
CURRENT-CARRYING CAPACITIES

CABLE TYPE: TWO SINGLE-CORE (See Note 1)

INSULATION TYPES: R-HF-110, R-E-110 OR X-HF-110

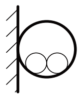
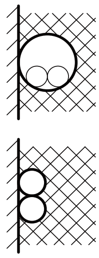
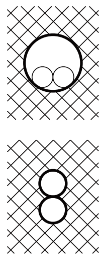
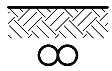
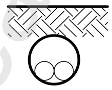
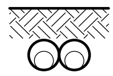
MAXIMUM CONDUCTOR TEMPERATURE: 110°C

REFERENCE AMBIENT TEMPERATURE: 30°C IN AIR, 15°C IN GROUND

1	2	3	4	5	6	7	8	9
Conductor size	Current-carrying capacity, A							
	Unenclosed							
	Spaced		Spaced from surface		Touching		Exposed to sun	
								
	Cu		Cu		Cu		Cu	
mm^2	Solid/ Stranded	Flexible	Solid/ Stranded	Flexible	Solid/ Stranded	Flexible	Solid/ Stranded	Flexible
1	27	28	26	28	21	22	18	19
1.5	34	34	33	34	27	28	22	24
2.5	48	46	47	45	39	36	32	31
4	63	61	62	60	50	48	42	41
6	80	78	78	75	63	61	54	51
10	110	109	106	105	87	86	73	72
16	147	144	140	138	114	112	95	94
25	196	190	187	182	153	149	127	124
35	241	236	229	225	188	184	156	153
50	295	299	279	281	230	233	190	192
70	373	376	351	352	291	292	240	240
95	464	452	434	423	363	352	296	288
120	540	535	504	499	422	417	343	340
150	622	617	578	574	486	482	395	392
185	720	706	668	654	564	552	457	447
240	862	850	795	783	674	664	544	535
300	999	980	917	900	781	766	627	615
400	1171	1182	1068	1076	913	920	730	735
500	1367	1380	1236	1245	1059	1069	844	850
630	1603	1636	1427	1454	1226	1250	973	990

(*continued*)

TABLE 6 (*continued*)

10	11	12	13	14	15	16	17	18
Conductor size	**Current-carrying capacity, A**							
	Enclosed		**Thermal insulation**		**Buried direct**	**Underground wiring enclosure**		
	Metallic wiring enclosure in air		**Partially surrounded by thermal insulation**	**Completely surrounded by thermal insulation**				
								
	Cu		**Cu**	**Cu**	**Cu**	**Cu**		**Cu**
mm²	**Solid/ Stranded**	**Flexible**				**Solid/ Stranded**	**Flexible**	
1	21	22	17	11	24	24	25	28
1.5	27	27	21	14	31	31	32	35
2.5	37	35	30	19	42	42	41	49
4	49	48	40	25	56	56	54	63
6	62	60	49	32	70	70	68	78
10	83	82	66	43	93	93	91	103
16	111	109	89	57	163	122	119	135
25	147	142	117	77	210	157	152	173
35	177	179	141	94	252	188	187	207
50	219	221	175	—	299	227	228	250
70	273	281	218	—	367	278	282	305
95	343	334	275	—	441	340	331	373
120	395	389	317	—	501	388	381	424
150	460	456	368	—	563	445	439	475
185	528	515	422	—	637	506	492	548
240	636	624	509	—	740	595	581	636
300	—	—	—	—	836	687	669	736
400	—	—	—	—	952	782	778	837
500	—	—	—	—	1079	887	906	976
630	—	—	—	—	1217	1031	1036	1108

NOTES TO TABLE 6:

1 Applies to non-armoured, sheathed or unsheathed cables.

2 See Tables 3(1), 3(2), 3(3) and 3(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.

3 Derating factors may apply as follows:

(a) The current-carrying capacities apply to single circuits. For grouped cable circuits, see Clause 3.5.2 and Tables 22, 23, 25(1), 25(2), 26(1) and 26(2) for appropriate derating factors.

(b) For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 6 and 7.

(c) For a single circuit fixed to perforated or unperforated cable tray, see Table 23 for the derating factor to be applied to the current-carrying capacities given in Columns 4 and 5.

(d) For ambient temperature and depth of laying factors, see Tables 27(1), 27(2), 28(1) and 28(2).

4 To determine the single-phase voltage drop of these configurations, refer to the appropriate value in Table 40, Table 41 or Table 46.

5 These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

6 For conductor sizes up to 10 mm^2 in Column 15, the values are based on ratings for wiring in underground wiring enclosures.

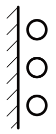
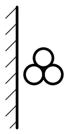
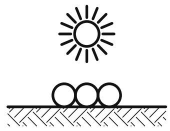
TABLE 7
CURRENT-CARRYING CAPACITIES

CABLE TYPE: THREE SINGLE-CORE (See Note 1)

INSULATION TYPE: THERMOPLASTIC (See Note 2)

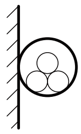
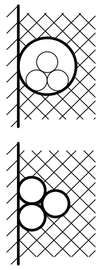
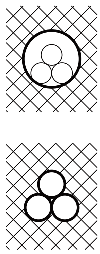
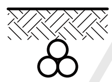
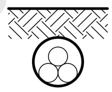
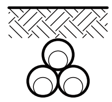
MAXIMUM CONDUCTOR TEMPERATURE: 75°C

REFERENCE AMBIENT TEMPERATURE: 30°C IN AIR, 15°C IN GROUND

1	2	3	4	5	6	7	8	9	10	11	12	13
Conductor size	Current-carrying capacity, A											
	Unenclosed											
	Spaced			Spaced from surface			Touching			Exposed to sun		
												
	Cu		Al	Cu		Al	Cu		Al	Cu		Al
mm²	Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible	
1	18	18	—	16	16	—	15	15	—	9	9	—
1.5	23	24	—	19	21	—	18	19	—	11	11	—
2.5	33	31	—	29	27	—	26	25	—	15	15	—
4	43	42	—	38	36	—	35	34	—	21	19	—
6	56	54	—	48	47	—	46	43	—	25	24	—
10	76	75	—	66	65	—	62	62	—	34	33	—
16	101	100	79	88	86	67	82	81	64	44	43	34
25	137	133	106	117	114	91	111	107	86	57	56	44
35	169	165	131	145	143	112	136	133	105	70	67	54
50	206	209	161	178	179	138	166	168	129	82	83	64
70	262	263	204	225	226	174	210	211	163	101	101	79
95	327	318	253	280	272	218	262	254	203	122	119	95
120	382	377	296	327	324	254	304	301	237	139	137	108
150	439	437	340	376	374	292	351	348	272	156	154	121
185	510	499	396	437	429	341	407	399	317	176	170	137
240	610	602	475	521	514	408	486	479	381	201	196	157
300	707	694	551	603	592	473	561	552	441	225	218	177
400	828	837	650	701	708	556	653	659	519	250	246	200
500	964	975	763	809	817	651	754	762	606	276	270	223
630	1129	1153	899	931	950	762	866	884	709	302	299	250

(continued)

TABLE 7 (*continued*)

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Conductor size	**Current-carrying capacity, A**													
	Enclosed			**Thermal insulation**				**Buried direct**		**Underground wiring enclosure**				
	Wiring enclosure in air			**Partially surrounded by thermal insulation**		**Completely surrounded by thermal insulation**								
														
	Cu		**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**		**Al**	**Cu**	**Al**
mm²	**Solid/ Stranded**	**Flexible**								**Solid/ Stranded**	**Flexible**			
1	14	15	—	11	—	7	—	18	—	18	18	—	21	—
1.5	17	17	—	14	—	9	—	22	—	22	22	—	26	—
2.5	24	23	—	19	—	14	—	30	—	30	29	—	36	—
4	32	31	—	26	—	18	—	40	—	40	39	—	47	—
6	40	39	—	32	—	23	—	50	—	50	47	—	58	—
10	54	52	—	42	—	31	—	65	—	65	64	—	77	—
16	71	70	55	57	44	41	32	114	89	86	84	66	99	77
25	92	89	72	73	57	55	43	147	114	110	107	86	129	100
35	114	112	89	91	71	67	52	176	136	134	131	103	154	119
50	136	137	105	108	84	—	—	209	162	158	160	123	185	144
70	173	173	135	139	107	—	—	256	199	198	198	154	226	175
95	209	203	162	168	130	—	—	307	238	239	231	185	275	213
120	247	243	193	197	154	—	—	349	272	277	272	216	311	242
150	278	275	217	222	173	—	—	392	304	311	307	242	349	271
185	324	316	253	259	202	—	—	442	344	358	348	278	402	312
240	377	383	307	302	236	—	—	512	400	415	414	325	464	362
300	442	432	348	355	278	—	—	576	453	477	465	375	537	418
400	504	526	400	402	320	—	—	652	518	541	554	430	608	477
500	596	593	480	477	384	—	—	735	591	628	623	505	705	558
630	670	675	548	537	439	—	—	823	673	703	705	575	795	636

NOTES TO TABLE 7:

1 Applies to non-armoured, sheathed or unsheathed cables.

2 The normal operating temperature of thermoplastic cables, including flexible cords installed as installation wiring, is based on a conductor temperature of 75°C. This is due to the risk of thermal deformation of insulation if the cables are clipped, fixed or otherwise installed in a manner that exposes the cable to severe mechanical pressure at higher temperatures.

V-90 and V-90HT insulated cables may be operated up to the maximum permissible temperatures 90°C and 105°C provided that the cable is installed in a manner that is not subject to, or is protected against, severe mechanical pressure at temperatures higher than 75°C. Such applications also allow for cables to be used in—

(a) locations where the ambient temperatures exceed the normal 30°C, e.g. equipment wiring in luminaires and heating appliances, or in roof spaces affected by high summer temperatures; and

(b) locations affected by bulk thermal insulation that restricts the dissipation of heat from the cable.

3 See Tables 3(1), 3(2), 3(3) and 3(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.

4 Derating factors may apply as follows:

(a) The current-carrying capacities apply to single circuits. For grouped cable circuits, see Clause 3.5.2 and Tables 22, 23, 25(1), 25(2), 26(1) and 26(2) for appropriate derating factors.

(b) For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 8 to 10.

(c) For a single circuit fixed to perforated or unperforated cable tray, see Table 23 for the derating factor to be applied to the current-carrying capacities given in Columns 5 to 7.

(d) For ambient temperature and depth of laying factors, see Tables 27(1), 27(2), 28(1) and 28(2).

5 To determine the three-phase voltage drop of these configurations, refer to the appropriate value in Table 40, Table 41, Table 43, Table 44 or Table 46.

6 These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

7 For conductor sizes up to 10 mm^2 in Column 22, the values are based on ratings for wiring in underground wiring enclosures.

8 Cables within the scope of AS/NZS 5000.2 (up to 16 mm^2) may be rated to the values in the Tables covering 90°C insulated cables, subject to—

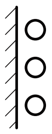
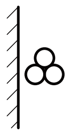
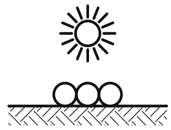
(a) information provided in Note 2; and

(b) any other relevant requirements of AS/NZS 3000.

TABLE 8

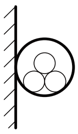
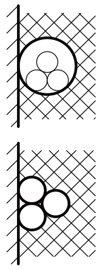
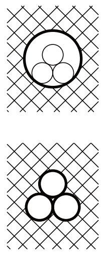
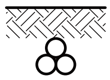
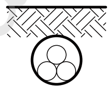
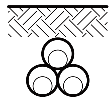
CURRENT-CARRYING CAPACITIES

CABLE TYPE:	**THREE SINGLE-CORE (See Note 1)**
INSULATION TYPES:	**X-90, X-HF-90, R-EP-90, R-CPE-90, R-HF-90 OR R-CSP-90**
MAXIMUM CONDUCTOR TEMPERATURE:	**90°C AND 105°C (See Note 2)**
REFERENCE AMBIENT TEMPERATURE:	**30°C IN AIR, 15°C IN GROUND**

1	2	3	4	5	6	7	8	9	10	11	12	13
Conductor size	Current-carrying capacity, A											
	Unenclosed											
	Spaced			Spaced from surface			Touching			Exposed to sun		
												
	Cu		Al	Cu		Al	Cu		Al	Cu		Al
mm^2	Solid/ Stranded	Flexi- ble		Solid/ Stranded	Flexi- ble		Solid/ Stranded	Flexi- ble		Solid/ Stranded	Flexi- ble	
1	21	22	—	18	19	—	18	18	—	13	14	—
1.5	28	28	—	23	24	—	22	22	—	17	18	—
2.5	39	36	—	33	32	—	31	30	—	23	23	—
4	51	50	—	44	42	—	41	40	—	31	30	—
6	65	63	—	55	54	—	52	51	—	40	37	—
10	89	88	—	76	76	—	72	70	—	53	53	—
16	119	117	92	101	100	78	95	94	74	70	69	55
25	161	156	124	138	133	107	129	125	100	95	91	73
35	198	195	154	169	166	131	158	155	122	116	113	89
50	243	245	188	207	210	161	194	196	150	140	141	109
70	310	311	241	264	265	205	246	248	191	176	177	136
95	385	375	298	328	319	255	306	298	238	217	211	168
120	451	447	350	384	381	298	358	354	278	252	249	196
150	519	517	403	443	440	344	413	409	320	288	286	223
185	616	594	470	515	505	402	479	470	373	332	326	259
240	726	716	564	616	608	482	573	565	448	394	387	308
300	843	827	656	713	701	559	662	650	519	451	442	354
400	989	1000	776	832	840	659	772	780	613	521	525	414
500	1156	1168	912	961	972	773	893	903	717	598	601	481
630	1353	1382	1076	1111	1133	906	1032	1052	842	683	693	558

(continued)

TABLE 8 (*continued*)

14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Conductor size	**Current-carrying capacity, A**													
	Enclosed			**Thermal insulation**				**Buried direct**		**Underground wiring enclosure**				
	Wiring enclosure in air			**Partially surrounded by thermal insulation**		**Completely surrounded by thermal insulation**								
														
	Cu		**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**		**Al**	**Cu**	**Al**
mm²	**Solid/ Stranded**	**Flexi-ble**								**Solid/ Stranded**	**Flexi-ble**			
1	17	17	—	13	—	9	—	19	—	19	20	—	24	—
1.5	20	21	—	17	—	11	—	24	—	24	25	—	29	—
2.5	28	26	—	22	—	15	—	33	—	33	32	—	41	—
4	36	34	—	29	—	21	—	43	—	43	41	—	52	—
6	46	45	—	37	—	26	—	54	—	54	52	—	64	—
10	62	61	—	50	—	35	—	72	—	72	71	—	85	—
16	79	80	62	64	50	47	36	125	97	92	91	71	108	85
25	107	103	83	85	66	64	50	162	125	121	117	93	141	110
35	132	130	102	106	83	79	62	193	150	147	143	113	169	131
50	157	158	122	125	98	—	—	229	178	174	174	135	203	157
70	201	201	156	161	125	—	—	280	217	217	217	169	248	193
95	242	235	188	194	151	—	—	335	260	261	254	203	295	229
120	287	282	223	230	178	—	—	381	296	304	299	236	342	265
150	325	320	252	260	201	—	—	428	332	342	338	266	383	296
185	369	367	287	295	230	—	—	484	377	388	382	303	442	343
240	439	430	343	352	275	—	—	560	438	456	445	356	510	397
300	516	504	405	413	323	—	—	630	495	525	513	412	591	460
400	587	586	466	470	373	—	—	715	567	596	593	473	670	525
500	696	693	560	557	448	—	—	805	646	693	687	556	756	598
630	785	791	641	628	513	—	—	902	736	778	780	635	877	700

NOTES TO TABLE 8:

1 Applies to non-armoured, sheathed or unsheathed cables.

2 The normal operating temperature of thermoplastic cables, including flexible cords installed as installation wiring, is based on a conductor temperature of 75°C. This is due to the risk of thermal deformation of insulation if the cables are clipped, fixed or otherwise installed in a manner that exposes the cable to severe mechanical pressure at higher temperatures.

V-90 and V-90HT insulated cables may be operated up to the maximum permissible temperatures 90°C and 105°C provided that the cable is installed in a manner that is not subject to, or is protected against, severe mechanical pressure at temperatures higher than 75°C. Such applications also allow for cables to be used in—

(a) locations where the ambient temperatures exceed the normal 30°C, e.g. equipment wiring in luminaires and heating appliances, or in roof spaces affected by high summer temperatures; and

(b) locations affected by bulk thermal insulation that restricts the dissipation of heat from the cable.

3 For cables with a maximum conductor temperature of 105°C, the applicable current ratings are those provided for copper conductors up to and including 10 mm^2 size.

4 See Tables 3(1), 3(2), 3(3) and 3(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.

5 Derating factors may apply as follows:

(a) The current-carrying capacities apply to single circuits. For grouped cable circuits, see Clause 3.5.2 and Tables 22, 23, 25(1), 25(2), 26(1) and 26(2) for appropriate derating factors.

(b) For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 8 to 10.

(c) For a single circuit fixed to perforated or unperforated cable tray, see Table 23 for the derating factor to be applied to the current-carrying capacities given in Columns 5 to 7.

(d) For ambient temperature and depth of laying factors, see Tables 27(1), 27(2), 28(1) and 28(2).

6 To determine the three-phase voltage drop of these configurations, refer to the appropriate value in Table 40, Table 41, Table 43, Table 44 or Table 46.

7 These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

8 For conductor sizes up to 10 mm^2 in Column 22, the values are based on ratings for wiring in underground wiring enclosures.

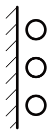
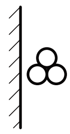
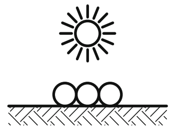
TABLE 9
CURRENT-CARRYING CAPACITIES

CABLE TYPE: THREE SINGLE-CORE (See Note 1)

INSULATION TYPES: R-HF-110, R-E-110 OR X-HF-110

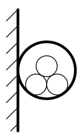
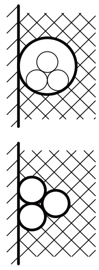
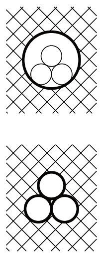
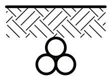
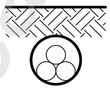
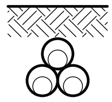
MAXIMUM CONDUCTOR TEMPERATURE: 110°C

REFERENCE AMBIENT TEMPERATURE: 30°C IN AIR, 15°C IN GROUND

1	2	3	4	5	6	7	8	9
Conductor size	Current-carrying capacity, A							
	Unenclosed							
	Spaced		Spaced from surface		Touching		Exposed to sun	
								
	Cu		Cu		Cu		Cu	
mm²	Solid/ Stranded	Flexible	Solid/ Stranded	Flexible	Solid/ Stranded	Flexible	Solid/ Stranded	Flexible
1	26	27	22	24	21	22	18	19
1.5	33	33	29	29	27	28	22	24
2.5	46	45	41	39	39	36	32	31
4	61	59	54	51	50	48	42	41
6	78	75	67	65	63	61	54	51
10	106	106	92	91	87	86	73	72
16	141	139	122	120	114	112	95	94
25	189	185	164	159	153	149	127	124
35	233	229	201	197	188	184	156	153
50	286	289	246	249	230	232	190	192
70	363	364	311	312	291	292	240	240
95	452	439	388	378	363	352	296	288
120	526	521	452	447	422	417	343	339
150	605	601	520	516	485	482	394	391
185	702	689	603	592	563	552	456	446
240	841	829	721	712	673	663	542	534
300	976	958	835	820	778	764	625	612
400	1144	1155	974	982	906	915	725	730
500	1335	1348	1127	1138	1050	1059	837	841
630	1564	1598	1302	1327	1211	1235	961	977

(continued)

TABLE 9 (*continued*)

10	11	12	13	14	15	16	17	18
Conductor size	**Current-carrying capacity, A**							
	Enclosed		**Thermal insulation**		**Buried direct**	**Underground wiring enclosure**		
	Metallic wiring enclosure in air		**Partially surrounded by thermal insulation**	**Completely surrounded by thermal insulation**				
								
	Cu		**Cu**	**Cu**	**Cu**	**Cu**		**Cu**
mm²	**Solid/ Stranded**	**Flexible**				**Solid/ Stranded**	**Flexible**	
1	18	19	15	11	21	21	22	25
1.5	24	25	19	14	27	27	28	32
2.5	34	33	27	19	38	38	36	45
4	44	43	35	25	49	49	47	57
6	55	54	44	32	60	60	58	71
10	76	75	61	43	82	82	81	93
16	100	97	79	57	138	105	103	122
25	134	129	107	77	178	138	133	157
35	162	158	129	94	213	164	160	187
50	195	203	156	—	251	195	199	225
70	250	250	200	—	308	244	243	275
95	305	296	244	—	369	294	284	334
120	361	354	288	—	420	341	335	378
150	409	404	327	—	472	384	378	424
185	480	469	384	—	533	440	428	489
240	586	576	470	—	618	522	510	565
300	670	655	536	—	696	589	575	654
400	768	810	615	—	791	669	687	742
500	926	924	740	—	894	780	773	864
630	1052	1063	842	—	1004	877	878	975

NOTES TO TABLE 9:

1 Applies to non-armoured, sheathed or unsheathed cables.

2 See Tables 3(1), 3(2), 3(3) and 3(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.

3 Derating factors may apply as follows:

(a) The current-carrying capacities apply to single circuits. For grouped cable circuits, see Clause 3.5.2 and Tables 22, 23, 25(1), 25(2), 26(1) and 26(2) for appropriate derating factors.

(b) For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 6 and 7.

(c) For a single circuit fixed to perforated or unperforated cable tray, see Table 23 for the derating factor to be applied to the current-carrying capacities given in Columns 4 and 5.

(d) For ambient temperature and depth of laying factors, see Tables 27(1), 27(2), 28(1) and 28(2).

4 To determine the three-phase voltage drop of these configurations, refer to the appropriate value in Table 40, Table 41 or Table 46.

5 These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

6 For conductor sizes up to 10 mm^2 in Column 15 the values are based on ratings for wiring in underground wiring enclosures.

TABLE 10

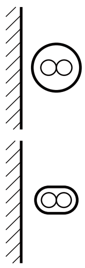
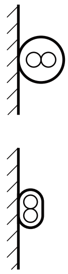
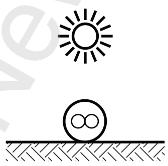
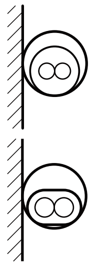
CURRENT-CARRYING CAPACITIES

CABLE TYPE: TWO-CORE SHEATHED (See Note 1)

INSULATION TYPE: THERMOPLASTIC (See Note 2)

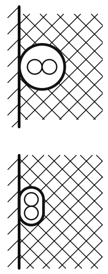
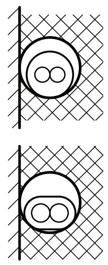
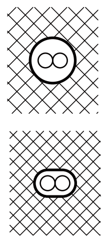
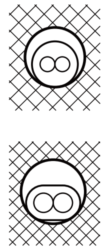
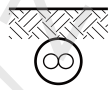
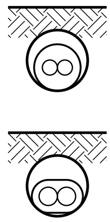
MAXIMUM CONDUCTOR TEMPERATURE: 75°C

REFERENCE AMBIENT TEMPERATURE: 30°C IN AIR, 15°C IN GROUND

1	2	3	4	5	6	7	8	9	10	11	12	13
Conductor size	Current-carrying capacity, A											
	Unenclosed									Enclosed		
	Spaced			Touching			Exposed to sun			Wiring enclosure in air		
												
	Cu		Al	Cu		Al	Cu		Al	Cu		Al
mm²	Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible	
1	17	18	—	16	17	—	13	14	—	15	15	—
1.5	22	23	—	21	21	—	16	16	—	18	19	—
2.5	31	30	—	30	29	—	23	22	—	26	26	—
4	42	40	—	39	38	—	31	30	—	34	33	—
6	52	51	—	50	48	—	39	36	—	44	43	—
10	73	72	—	68	67	—	52	51	—	59	58	—
16	97	95	75	91	89	71	68	67	54	78	78	59
25	129	125	100	122	119	95	90	88	71	103	99	80
35	158	156	123	149	146	115	111	107	86	128	124	99
50	194	195	150	181	184	141	132	133	103	152	153	117
70	245	245	190	229	230	178	165	165	128	194	193	150
95	302	293	234	283	275	219	200	194	155	233	226	180
120	350	347	272	328	325	255	230	227	179	275	269	213
150	400	397	310	374	372	291	259	257	202	309	304	239
185	459	450	358	430	422	335	294	287	229	357	348	278
240	544	536	425	508	500	398	342	335	268	415	420	325
300	624	612	489	583	572	457	386	377	303	483	473	380
400	719	725	570	671	676	532	438	438	348	549	570	437
500	816	830	656	762	773	611	489	491	393	640	643	514

(*continued*)

TABLE 10 (*continued*)

14	15	16	17	18	19	20	21	22	23	24	25	26	27
Conductor size	Current-carrying capacity, A												
	Thermal insulation								Buried direct		Underground wiring enclosure		
	Partially surrounded by thermal insulation, unenclosed		Partially surrounded by thermal insulation, in a wiring enclosure		Completely surrounded by thermal insulation, unenclosed		Completely surrounded by thermal insulation, in a wiring enclosure						
													
											Cu		
mm²	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Solid/ Stranded	Flexible	Al
1	13	—	11	—	8	—	7	—	19	—	19	20	—
1.5	16	—	15	—	10	—	9	—	23	—	23	24	—
2.5	23	—	22	—	15	—	14	—	33	—	33	32	—
4	31	—	27	—	19	—	17	—	43	—	43	42	—
6	40	—	35	—	25	—	23	—	55	—	55	53	—
10	55	—	48	—	34	—	30	—	73	—	73	72	—
16	73	56	62	48	46	35	39	30	125	97	95	94	73
25	97	75	82	64	60	47	51	40	162	125	123	119	96
35	120	92	103	80	74	58	64	49	196	152	150	146	117
50	145	113	122	95	—	—	—	—	232	179	178	179	139
70	184	143	155	120	—	—	—	—	285	221	222	222	173
95	226	176	186	145	—	—	—	—	342	265	267	260	208
120	262	204	219	171	—	—	—	—	391	304	310	305	242
150	300	233	247	192	—	—	—	—	438	340	349	344	271
185	344	268	285	222	—	—	—	—	494	385	399	388	311
240	407	318	332	260	—	—	—	—	572	447	463	461	362
300	466	366	388	303	—	—	—	—	645	506	531	519	417
400	537	425	440	349	—	—	—	—	729	579	603	616	477
500	609	489	512	410	—	—	—	—	815	655	691	692	554

NOTES TO TABLE 10:

1 Applies to cables with or without earth core, armoured or unarmoured, including neutral screened cables.

2 The normal operating temperature of thermoplastic cables, including flexible cords installed as installation wiring, is based on a conductor temperature of 75°C. This is due to the risk of thermal deformation of insulation if the cables are clipped, fixed or otherwise installed in a manner that exposes the cable to severe mechanical pressure at higher temperatures.

V-90 and V-90HT insulated cables may be operated up to the maximum permissible temperatures 90°C and 105°C provided that the cable is installed in a manner that is not subject to, or is protected against, severe mechanical pressure at temperatures higher than 75°C. Such applications also allow for cables to be used in—

(a) locations where the ambient temperatures exceed the normal 30°C, e.g. equipment wiring in luminaires and heating appliances, or in roof spaces affected by high summer temperatures; and

(b) locations affected by bulk thermal insulation that restricts the dissipation of heat from the cable.

3 See Tables 3(1), 3(2), 3(3) and 3(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.

4 Derating factors may apply as follows:

(a) The current-carrying capacities apply to single circuits. For grouped cable circuits, see Clause 3.5.2 and Tables 22, 23, 25(1), 25(2), 26(1) and 26(2) for appropriate derating factors.

(b) For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 23 for the derating factor to be applied to the current-carrying capacities given in Columns 5 to 7.

(c) For a single circuit fixed to unperforated cable tray, see Table 24 for the derating factor to be applied to the current-carrying capacities given in Columns 2 to 4.

(d) For ambient temperature and depth of laying factors, see Tables 27(1), 27(2), 28(1) and 28(2).

5 To calculate the single-phase voltage drop of these configurations, multiply the appropriate three-phase voltage drop value in Table 42, Table 45 or Table 48 by 1.155.

6 These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

7 For conductor sizes up to 10 mm^2 in Column 23, the values are based on ratings for wiring in underground wiring enclosures.

8 Cables within the scope of AS/NZS 5000 (up to 25 mm^2 and with a maximum permissible conductor operating temperature of not less than 90°C) may be rated to the values in the Table 11 covering 90°C insulated cables, subject to—

(a) information provided in Note 2; and

(b) any other relevant requirements of AS/NZS 3000.

9 Refer to Paragraph C3 of AS/NZS 3000 for details on simplified protective device selection (MCBs) for overload protection.

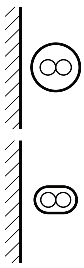
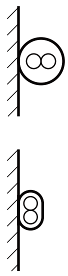
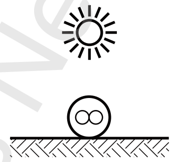
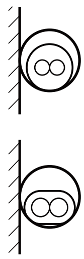
TABLE 11
CURRENT-CARRYING CAPACITIES

CABLE TYPE: TWO-CORE SHEATHED (See Note 1)

INSULATION TYPES: X-90, X-HF-90, R-EP-90, R-CPE-90, R-HF-90 OR R-CSP-90

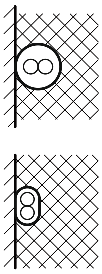
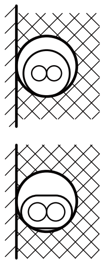
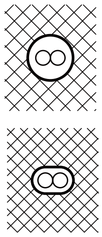
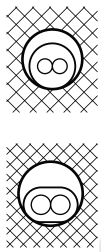
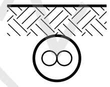
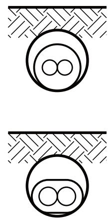
MAXIMUM CONDUCTOR TEMPERATURE: 90°C AND 105°C (See Note 2)

REFERENCE AMBIENT TEMPERATURE: 30°C IN AIR, 15°C IN GROUND

1	2	3	4	5	6	7	8	9	10	11	12	13
Conductor size	Current-carrying capacity, A											
	Unenclosed									Enclosed		
	Spaced			Touching			Exposed to sun			Wiring enclosure in air		
												
	Cu		Al	Cu		Al	Cu		Al	Cu		Al
mm²	Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible	
1	20	21	—	19	20	—	17	18	—	18	18	—
1.5	26	26	—	24	25	—	21	22	—	22	22	—
2.5	37	35	—	34	33	—	30	29	—	31	30	—
4	50	47	—	46	44	—	40	39	—	41	39	—
6	63	61	—	58	56	—	51	48	—	51	48	—
10	86	86	—	80	79	—	69	68	—	69	68	—
16	114	113	89	107	106	83	91	90	70	90	88	69
25	154	150	120	144	141	112	122	119	95	121	117	94
35	190	186	147	178	174	138	150	147	117	145	142	112
50	232	234	179	217	219	168	182	184	141	178	179	139
70	295	296	229	275	276	213	229	230	178	220	228	171
95	364	354	283	340	330	263	281	273	218	275	266	213
120	424	419	329	395	391	307	325	321	253	314	318	244
150	485	482	376	452	449	351	370	366	287	365	361	283
185	560	549	436	520	510	406	424	415	330	415	413	322
240	664	656	519	618	609	483	499	491	389	493	483	385
300	763	750	598	710	696	556	570	558	447	575	562	451
400	884	892	700	820	826	649	653	657	517	656	655	519
500	1007	1025	807	933	948	748	738	747	592	765	769	613

(*continued*)

TABLE 11 (*continued*)

14	15	16	17	18	19	20	21	22	23	24	25	26	27
Conductor size	**Current-carrying capacity, A**												
	Thermal insulation								**Buried direct**		**Underground wiring enclosure**		
	Partially surrounded by thermal insulation, unenclosed		**Partially surrounded by thermal insulation, in a wiring enclosure**		**Completely surrounded by thermal insulation, unenclosed**		**Completely surrounded by thermal insulation, in a wiring enclosure**						
													
											Cu		
mm²	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Solid/ Stranded**	**Flexible**	**Al**
1	15	—	13	—	10	—	9	—	20	—	20	21	—
1.5	20	—	18	—	12	—	11	—	26	—	26	27	—
2.5	28	—	25	—	18	—	15	—	36	—	36	35	—
4	36	—	32	—	23	—	20	—	48	—	48	46	—
6	46	—	41	—	30	—	25	—	60	—	60	58	—
10	64	—	56	—	40	—	35	—	80	—	80	79	—
16	86	66	73	56	54	42	45	35	141	109	105	102	80
25	116	89	97	75	73	56	61	47	182	141	137	133	106
35	142	110	117	90	89	69	73	56	219	170	165	161	127
50	174	134	143	111	—	—	—	—	261	202	198	199	154
70	220	171	176	136	—	—	—	—	321	249	244	247	189
95	272	211	220	171	—	—	—	—	385	299	299	290	231
120	316	245	251	195	—	—	—	—	439	341	340	340	264
150	361	281	292	227	—	—	—	—	492	382	391	385	303
185	417	325	331	259	—	—	—	—	556	433	442	435	345
240	494	386	394	308	—	—	—	—	645	504	519	508	406
300	568	444	460	361	—	—	—	—	728	570	597	582	468
400	656	519	525	416	—	—	—	—	825	653	677	675	536
500	746	598	612	491	—	—	—	—	922	739	779	780	624

NOTES TO TABLE 11:

1 Applies to cables with or without earth core, armoured or unarmoured, including neutral screened cables.

2 The normal operating temperature of thermoplastic cables, including flexible cords installed as installation wiring, is based on a conductor temperature of 75°C. This is due to the risk of thermal deformation of insulation if the cables are clipped, fixed or otherwise installed in a manner that exposes the cable to severe mechanical pressure at higher temperatures.

V-90 and V-90HT insulated cables may be operated up to the maximum permissible temperatures 90°C and 105°C provided that the cable is installed in a manner that is not subject to, or is protected against, severe mechanical pressure at temperatures higher than 75°C. Such applications also allow for cables to be used in—

(a) locations where the ambient temperatures exceed the normal 30°C, e.g. equipment wiring in luminaires and heating appliances, or in roof spaces affected by high summer temperatures; and

(b) locations affected by bulk thermal insulation that restricts the dissipation of heat from the cable.

3 For cables with a maximum conductor temperature of 105°C the applicable current ratings are those provided for copper conductors up to and including 10 mm^2 size.

4 See Tables 3(1), 3(2), 3(3) and 3(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.

5 Derating factors may apply as follows:

(a) The current-carrying capacities apply to single circuits. For grouped cable circuits, see Clause 3.5.2 and Tables 22, 24, 25(1), 25(2), 26(1) and 26(2) for appropriate derating factors.

(b) For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 5 to 7.

(c) For a single circuit fixed to unperforated cable tray, see Table 24 for the derating factor to be applied to the current-carrying capacities given in Columns 2 to 4.

(d) For ambient temperature and depth of laying factors, see Tables 27(1), 27(2), 28(1) and 28(2).

6 To calculate the single-phase voltage drop of these configurations, multiply the appropriate three-phase voltage drop value in Table 42, Table 45 or Table 48 by 1.155.

7 These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

8 For conductor sizes up to 10 mm^2 in Column 23, the values are based on ratings for wiring in underground wiring enclosures.

9 Cables within the scope of AS/NZS 5000 (up to 25 mm^2) may be rated to the values in this Table covering 90°C insulated cables, subject to—

(a) information provided in Note 2; and

(b) any other relevant requirements of AS/NZS 3000.

10 Refer to Paragraph C3 of AS/NZS 3000 for details on simplified protective device selection (MCBs) for overload protection.

TABLE 12

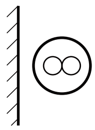
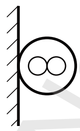
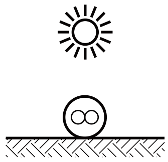
CURRENT-CARRYING CAPACITIES

CABLE TYPE: TWO-CORE SHEATHED (See Note 1)

INSULATION TYPES: R-HF-110, R-E-110 OR X-HF-110

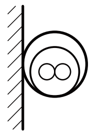
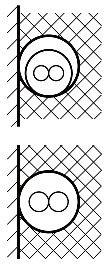
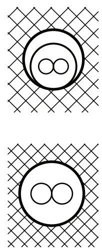
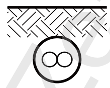
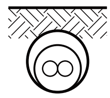
MAXIMUM CONDUCTOR TEMPERATURE: 110°C

REFERENCE AMBIENT TEMPERATURE: 30°C IN AIR, 15°C IN GROUND

1	2	3	4	5	6	7
Conductor size	Current-carrying capacity, A					
	Unenclosed					
	Spaced		Touching		Exposed to sun	
						
	Cu		Cu		Cu	
mm^2	Solid/ Stranded	Flexible	Solid/ Stranded	Flexible	Solid/ Stranded	Flexible
1	25	26	24	25	21	22
1.5	31	32	30	30	27	28
2.5	44	43	42	41	39	36
4	59	57	55	54	50	48
6	74	72	70	67	63	61
10	102	101	95	94	87	86
16	135	133	126	124	114	112
25	180	174	169	165	152	148
35	220	216	208	203	186	182
50	269	272	253	255	226	228
70	339	340	319	320	284	285
95	419	408	393	382	349	339
120	487	482	456	450	403	398
150	555	551	520	516	459	455
185	640	627	598	585	525	515
240	758	747	708	698	621	610
300	872	855	813	797	710	696
400	1007	1015	939	946	816	821
500	1149	1167	1070	1085	927	938

(continued)

TABLE 12 (*continued*)

8	9	10	11	12	13	14	15
Conductor size	**Current-carrying capacity, A**						
	Enclosed		**Thermal insulation**		**Buried direct**	**Underground wiring enclosure**	
	Metallic wiring enclosure in air		**Partially surrounded by thermal insulation**	**Completely surrounded by thermal insulation**			
							
	Cu		**Cu**	**Cu**	**Cu**	**Cu**	
mm²	**Solid/ Stranded**	**Flexible**				**Solid/ Stranded**	**Flexible**
1	20	21	16	12	23	23	24
1.5	26	26	20	15	30	30	31
2.5	35	34	29	20	41	41	39
4	48	46	39	28	54	54	52
6	60	58	48	35	68	68	66
10	81	80	64	48	90	90	89
16	109	107	87	63	154	118	116
25	142	138	114	85	199	153	147
35	178	174	142	104	240	186	181
50	214	216	171	—	284	220	222
70	274	275	219	—	350	276	275
95	334	324	268	—	420	332	322
120	394	387	315	—	479	385	378
150	446	441	356	—	537	434	427
185	520	507	416	—	607	496	483
240	629	617	503	—	705	587	573
300	717	702	574	—	796	664	648
400	822	857	658	—	904	754	771
500	968	977	775	—	1014	868	869

NOTES TO TABLE 12:

1 Applies to cables with or without earth core, armoured or non-armoured, including neutral screened cables.

2 See Tables 3(1), 3(2), 3(3) and 3(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.

3 Derating factors may apply as follows:

(a) The current-carrying capacities apply to single circuits. For grouped cable circuits, see Clause 3.5.2 and Tables 22, 24, 25(1), 25(2), 26(1) and 26(2) for approximate derating factors.

(b) For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Column 4 and 5.

(c) For a single circuit fixed to unperforated cable tray, see Table 24 for the derating factor to be applied to the current-carrying capacities given in Columns 2 and 3.

(d) For ambient temperature and depth of laying factors, see Tables 27(1), 27(2), 28(1) and 28(2).

4 To calculate the single-phase voltage drop of these configurations, multiply the appropriate three-phase voltage drop value in Table 42 or Table 48 by 1.155.

5 These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

6 For conductor sizes up to 10 mm^2 in Column 13 the values are based on ratings for wiring in underground wiring enclosures.

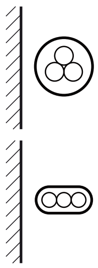
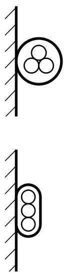
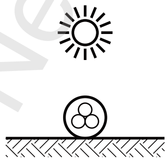
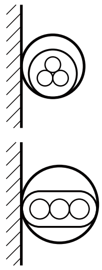
TABLE 13
CURRENT-CARRYING CAPACITIES

CABLE TYPES: THREE-CORE AND FOUR-CORE (See Note 1)

INSULATION TYPE: THERMOPLASTIC (See Note 2)

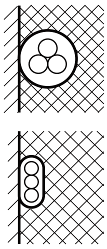
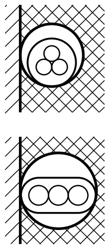
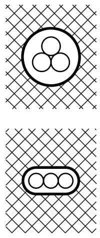
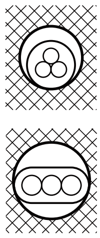
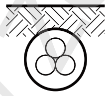
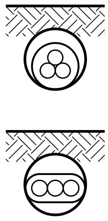
MAXIMUM CONDUCTOR TEMPERATURE: 75°C

REFERENCE AMBIENT TEMPERATURE: 30°C IN AIR, 15°C IN GROUND

1	2	3	4	5	6	7	8	9	10	11	12	13
Conductor size	Current-carrying capacity, A											
	Unenclosed									Enclosed		
	Spaced			Touching			Exposed to sun			Wiring enclosure in air		
												
	Cu		Al	Cu		Al	Cu		Al	Cu		Al
mm²	Solid/ Stranded	Flexi- ble		Solid/ Stranded	Flexi- ble		Solid/ Stranded	Flexi- ble		Solid/ Stranded	Flexi- ble	
1	15	15	—	14	15	—	10	11	—	13	13	—
1.5	18	19	—	17	18	—	14	14	—	16	16	—
2.5	26	25	—	25	24	—	19	18	—	23	22	—
4	35	34	—	33	32	—	26	25	—	29	27	—
6	46	43	—	42	41	—	33	32	—	38	36	—
10	62	62	—	58	58	—	44	43	—	50	49	—
16	82	81	64	78	76	60	58	57	46	66	65	51
25	111	107	86	104	101	81	76	74	59	87	83	67
35	137	133	106	128	125	99	93	91	73	107	105	83
50	166	169	129	156	157	121	113	114	88	128	128	99
70	211	211	163	196	197	153	140	140	109	162	162	127
95	260	253	202	243	236	188	171	165	132	202	196	156
120	302	299	235	282	278	219	196	193	153	230	227	179
150	345	343	268	321	319	250	221	219	172	260	261	202
185	397	390	310	369	363	288	251	245	196	300	293	235
240	470	464	368	437	431	343	292	286	228	360	352	283
300	538	529	424	499	490	393	328	321	259	—	—	—
400	620	626	495	575	579	458	372	372	296	—	—	—
500	702	715	568	651	661	526	414	416	335	—	—	—

(continued)

TABLE 13 (*continued*)

14	15	16	17	18	19	20	21	22	23	24	25	26	27
Conductor size	Current-carrying capacity, A												
	Thermal insulation								Buried direct		Underground wiring enclosure		
	Partially surrounded by thermal insulation, unenclosed		Partially surrounded by thermal insulation, in a wiring enclosure		Completely surrounded by thermal insulation, unenclosed		Completely surrounded by thermal insulation, in a wiring enclosure						
													
											Cu		
mm²	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Solid/ Stranded	Flexible	Al
1	10	—	10	—	7	—	6	—	15	—	15	17	—
1.5	14	—	13	—	9	—	8	—	20	—	20	20	—
2.5	19	—	18	—	13	—	11	—	28	—	28	26	—
4	26	—	23	—	17	—	15	—	36	—	36	35	—
6	34	—	30	—	22	—	18	—	46	—	46	44	—
10	47	—	40	—	29	—	25	—	61	—	61	59	—
16	62	48	54	41	39	30	33	26	106	83	80	78	62
25	83	65	68	54	52	40	43	33	138	107	103	100	80
35	103	79	86	66	64	49	54	41	165	129	125	123	98
50	124	97	101	79	—	—	—	—	196	152	150	151	116
70	157	122	130	100	—	—	—	—	241	187	187	186	145
95	194	150	162	125	—	—	—	—	289	224	229	221	177
120	226	176	185	144	—	—	—	—	330	256	261	255	202
150	258	200	207	162	—	—	—	—	370	287	293	292	228
185	295	231	241	188	—	—	—	—	417	326	334	326	261
240	350	274	288	226	—	—	—	—	482	378	395	386	309
300	—	—	—	—	—	—	—	—	542	427	444	433	350
400	—	—	—	—	—	—	—	—	613	488	515	514	411
500	—	—	—	—	—	—	—	—	682	551	574	575	464

NOTES TO TABLE 13:

1 Applies to cables with or without earth core, armoured or non-armoured, including neutral screened cables.

2 The normal operating temperature of thermoplastic cables, including flexible cords installed as installation wiring, is based on a conductor temperature of 75°C. This is due to the risk of thermal deformation of insulation if the cables are clipped, fixed or otherwise installed in a manner that exposes the cable to severe mechanical pressure at higher temperatures.

V-90 and V-90HT insulated cables may be operated up to the maximum permissible temperatures 90°C and 105°C provided that the cable is installed in a manner that is not subject to, or is protected against, severe mechanical pressure at temperatures higher than 75°C. Such applications also allow for cables to be used in—

(a) locations where the ambient temperatures exceed the normal 30°C, e.g. equipment wiring in luminaires and heating appliances, or in roof spaces affected by high summer temperatures; and

(b) locations affected by bulk thermal insulation that restricts the dissipation of heat from the cable.

3 See Tables 3(1), 3(2), 3(3) and 3(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.

4 Derating factors may apply as follows:

(a) The current-carrying capacities apply to single circuits. For grouped cable circuits, see Clause 3.5.2 and Tables 22, 24, 25(1), 25(2), 26(1) and 26(2) for appropriate derating factors.

(b) For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 5 to 7.

(c) For a single circuit fixed to unperforated cable tray, see Table 24 for the derating factor to be applied to the current-carrying capacities given in Columns 2 to 4.

(d) For ambient temperature and depth of laying factors, see Tables 27(1), 27(2), 28(1) and 28(2).

5 To determine the three-phase voltage drop of these configurations, refer to the appropriate value in Table 42, Table 45 or Table 48.

6 These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

7 For conductor sizes up to 10 mm^2 in Column 23, the values are based on ratings for wiring in underground wiring enclosures.

8 Cables within the scope of AS/NZS 5000 (up to 25 mm^2) may be rated to the values in the Table 14 covering 90°C insulated cables, subject to—

(a) information provided in Note 2; and

(b) any other relevant requirements of AS/NZS 3000.

9 Refer to Paragraph C3 of AS/NZS 3000 for details on simplified protective device selection (MCBs) for overload protection.

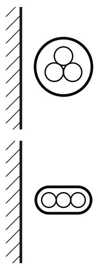
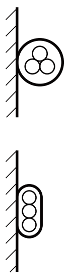
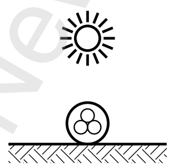
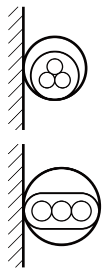
TABLE 14
CURRENT-CARRYING CAPACITIES

CABLE TYPES: THREE-CORE AND FOUR-CORE (See Note 1)

INSULATION TYPES: X-90, X-HF-90, R-EP-90, R-CPE-90, R-HF-90 OR R-CSP-90

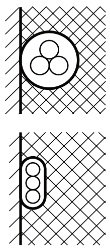
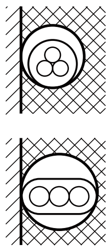
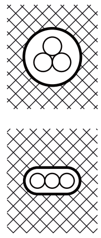
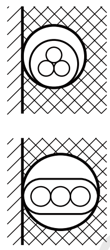
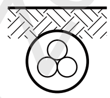
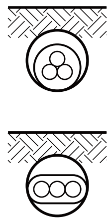
MAXIMUM CONDUCTOR TEMPERATURE: 90°C AND 105°C (See Note 2)

REFERENCE AMBIENT TEMPERATURE: 30°C IN AIR, 15°C IN GROUND

1	2	3	4	5	6	7	8	9	10	11	12	13
Conductor size	Current-carrying capacity, A											
	Unenclosed									Enclosed		
	Spaced			Touching			Exposed to sun			Wiring enclosure in air		
												
	Cu		Al	Cu		Al	Cu		Al	Cu		Al
mm²	Solid/ Stranded	Flexi-ble		Solid/ Stranded	Flexi-ble		Solid/ Stranded	Flexi-ble		Solid/ Stranded	Flexi-ble	
1	18	18	—	15	17	—	14	14	—	14	15	—
1.5	22	22	—	21	21	—	18	19	—	18	19	—
2.5	31	30	—	29	29	—	25	24	—	26	25	—
4	42	40	—	39	37	—	33	2	—	33	32	—
6	53	51	—	50	47	—	43	41	—	42	41	—
10	73	73	—	68	67	—	58	57	—	58	57	—
16	97	96	75	91	89	70	77	76	59	75	74	58
25	131	128	102	122	119	95	103	101	80	100	98	78
35	162	158	125	151	149	117	127	124	98	125	122	97
50	198	200	154	185	187	143	154	156	120	150	150	116
70	252	253	196	234	235	182	195	195	151	190	190	147
95	311	303	242	289	282	224	239	232	185	230	222	178
120	363	360	282	337	333	262	276	273	215	271	266	211
150	415	413	322	385	383	299	314	311	244	305	301	238
185	480	471	374	444	436	347	360	352	281	354	345	276
240	569	562	446	527	519	413	424	417	332	425	417	333
300	653	642	514	604	593	475	483	473	380	—	—	—
400	754	761	601	695	702	554	552	554	440	—	—	—
500	857	873	692	790	803	637	623	630	503	—	—	—

(*continued*)

TABLE 14 (*continued*)

14	15	16	17	18	19	20	21	22	23	24	25	26	27
Conductor size	Current-carrying capacity, A												
	Thermal insulation								Buried direct		Underground wiring enclosure		
	Partially surrounded by thermal insulation, unenclosed		Partially surrounded by thermal insulation, in a wiring enclosure		Completely surrounded by thermal insulation, unenclosed		Completely surrounded by thermal insulation, in a wiring enclosure						
													
											Cu		
mm²	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Cu	Al	Solid/ Stranded	Flexible	Al
1	13	—	11	—	8	—	7	—	17	—	17	18	—
1.5	17	—	14	—	10	—	9	—	21	—	21	22	—
2.5	23	—	21	—	14	—	13	—	31	—	31	30	—
4	31	—	26	—	20	—	17	—	40	—	40	39	—
6	40	—	33	—	24	—	21	—	49	—	49	48	—
10	54	—	46	—	34	—	29	—	67	—	67	66	—
16	73	56	61	46	45	35	37	29	118	91	87	85	67
25	98	76	80	63	62	47	51	40	153	119	114	110	89
35	121	94	100	78	76	58	63	48	184	142	139	136	108
50	147	114	119	92	—	—	—	—	218	170	166	166	128
70	187	145	152	118	—	—	—	—	269	209	207	207	161
95	231	179	184	142	—	—	—	—	323	250	249	242	194
120	270	209	217	168	—	—	—	—	368	286	289	285	225
150	308	240	244	189	—	—	—	—	412	320	325	321	253
185	355	277	283	221	—	—	—	—	465	364	372	363	291
240	421	330	340	266	—	—	—	—	539	423	440	430	345
300	—	—	—	—	—	—	—	—	607	477	495	484	391
400	—	—	—	—	—	—	—	—	685	546	561	575	446
500	—	—	—	—	—	—	—	—	764	617	643	644	519

NOTES TO TABLE 14:

1 Applies to cables with or without earth core, armoured or non-armoured, including neutral screened cables.

2 The normal operating temperature of thermoplastic cables, including flexible cords installed as installation wiring, is based on a conductor temperature of 75°C. This is due to the risk of thermal deformation of insulation if the cables are clipped, fixed or otherwise installed in a manner that exposes the cable to severe mechanical pressure at higher temperatures.

V-90 and V-90HT insulated cables may be operated up to the maximum permissible temperatures 90°C and 105°C provided that the cable is installed in a manner that is not subject to, or is protected against, severe mechanical pressure at temperatures higher than 75°C. Such applications also allow for cables to be used in—

(a) locations where the ambient temperatures exceed the normal 30°C, e.g. equipment wiring in luminaires and heating appliances, or in roof spaces affected by high summer temperatures; and

(b) locations affected by bulk thermal insulation that restricts the dissipation of heat from the cable.

3 For cables with a maximum conductor temperature of 105°C the applicable current ratings are those provided for copper conductors up to and including 10 mm^2 size.

4 See Tables 3(1), 3(2), 3(3) and 3(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.

5 Derating factors may apply as follows:

(a) The current-carrying capacities apply to single circuits. For grouped cable circuits, see Clause 3.5.2 and Tables 22, 24, 25(1), 25(2), 26(1) and 26(2) for appropriate derating factors.

(b) For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Tables 26(1) and 26(2) for the derating factor to be applied to the current-carrying capacities given in Columns 5 to 7.

(c) For a single circuit fixed to unperforated cable tray, see Table 24 for the derating factor to be applied to the current-carrying capacities given in Columns 2 to 4.

(d) For ambient temperature and depth of laying factors, see Tables 27(1), 27(2), 28(1) and 28(2).

6 To determine the three-phase voltage drop of these configurations, refer to the appropriate value in Table 42, Table 45 or Table 48.

7 These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

8 For conductor sizes up to 10 mm^2 in Column 23, the values are based on ratings for wiring in underground wiring enclosures

9 Cables within the scope of AS/NZS 5000 (up to 25 mm^2) may be rated to the values in Table 11 covering 90°C insulated cables, subject to—

(a) information provided in Note 2; and

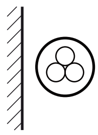
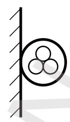
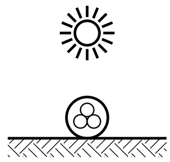
(b) any other relevant requirements of AS/NZS 3000.

10 Refer to Paragraph C3 of AS/NZS 3000 for details on simplified protective device selection (MCBs) for overload protection.

TABLE 15

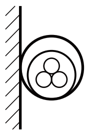
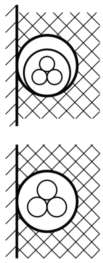
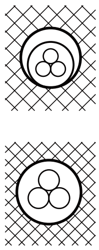
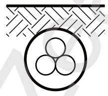
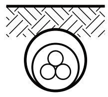
CURRENT-CARRYING CAPACITIES

CABLE TYPES:	**THREE-CORE AND FOUR-CORE SHEATHED (See Note 1)**
INSULATION TYPES:	**R-HF-110, R-E-110 OR X-HF-110**
MAXIMUM CONDUCTOR TEMPERATURE:	**110°C**
REFERENCE AMBIENT TEMPERATURE:	**30°C IN AIR, 15°C IN GROUND**

1	2	3	4	5	6	7
Conductor size	Current-carrying capacity, A					
	Unenclosed					
	Spaced		Touching		Exposed to sun	
						
	Cu		Cu		Cu	
mm²	Solid/ Stranded	Flexible	Solid/ Stranded	Flexible	Solid/ Stranded	Flexible
1	21	22	19	20	18	19
1.5	27	28	26	26	24	24
2.5	37	36	35	34	32	31
4	50	48	47	45	43	42
6	63	61	60	58	54	52
10	87	86	81	80	74	73
16	114	113	108	106	97	95
25	154	150	144	140	129	126
35	189	185	178	173	158	155
50	231	233	216	218	193	195
70	291	292	273	273	243	243
95	361	350	336	327	297	290
120	418	414	389	385	345	340
150	478	475	445	442	393	389
185	551	540	513	503	450	441
240	654	644	607	598	531	522
300	750	736	696	683	607	594
400	867	874	804	809	697	701
500	985	1002	912	926	789	798

(*continued*)

TABLE 15 (*continued*)

8	9	10	11	12	13	14	15
Conductor size	Current-carrying capacity, A						
	Enclosed		Thermal insulation		Buried direct	Underground wiring enclosure	
	Metallic wiring enclosure in air		Partially surrounded by thermal insulation	Completely surrounded by thermal insulation			
							
	Cu		Cu	Cu	Cu	Cu	
mm^2	Solid/ Stranded	Flexible				Solid/ Stranded	Flexible
1	17	18	14	10	20	20	21
1.5	21	22	17	13	25	25	25
2.5	31	29	25	18	35	35	33
4	41	39	32	24	46	46	43
6	50	49	41	30	56	56	54
10	68	70	55	41	75	75	75
16	92	90	73	54	129	99	96
25	124	120	100	72	167	129	125
35	150	147	120	89	201	155	152
50	186	187	149	—	240	188	189
70	232	232	185	—	294	230	230
95	289	281	231	—	353	283	275
120	333	327	266	—	402	322	316
150	385	381	308	—	452	367	361
185	440	430	352	—	510	414	404
240	533	523	426	—	591	491	480
300	—	—	—	—	667	553	540
400	—	—	—	—	756	644	642
500	—	—	—	—	845	721	721

NOTES TO TABLE 15:

1 Applies to cables with or without earth core, armoured or non-armoured, including neutral screened cables.

2 See Tables 3(1), 3(2), 3(3) and 3(4) for cable configurations deemed to have the same current-carrying capacities as those illustrated.

3 Derating factors may apply as follows:

(a) The current-carrying capacities apply to single circuits. For grouped cable circuits, see Clause 3.5.2 and Tables 22, 24, 25(1), 25(2), 26(1) and 26(2) for appropriate derating factors.

(b) For a single circuit fixed to the underside of a ceiling or similar horizontal surface, see Table 22 for the derating factor to be applied to the current-carrying capacities given in Columns 5 to 7.

(c) For a single circuit fixed to unperforated cable tray, see Table 24 for the derating factor to be applied to the current-carrying capacities given in Columns 2 to 4.

(d) For ambient temperature and depth of laying factors, see Tables 27(1), 27(2), 28(1) and 28(2).

4 To determine the three-phase voltage drop of these configurations, refer to the appropriate value in Table 42 or Table 48.

5 These ratings are based on 30°C ambient air temperature and 15°C ambient soil temperature. For other conditions, see Clause 3.5.3.

6 For conductor sizes up to 10 mm^2 in Column 13, the values are based on ratings for wiring in underground wiring enclosures.

TABLE 16

CURRENT-CARRYING CAPACITIES

CABLE TYPE:	**FLEXIBLE CORDS**
INSULATION TYPES:	**THERMOPLASTIC OR CROSS-LINKED**
MAXIMUM CONDUCTOR TEMPERATURE:	**60°C**
REFERENCE AMBIENT TEMPERATURE:	**25°C IN AIR**

Conductor size mm^2	**Current-carrying capacity** **A**
0.5	3 (See Note 2)
0.75	7.5
1.0	10
1.5	16
2.5	20
4.0	25

NOTES:

1 Where a flexible cord is wound on a drum, multiply current-carrying capacity by the appropriate factor, as follows:

Number of layers:	1	2	3	4
Derating factor:	0.76	0.58	0.47	0.40

2 Flexible cords having tinsel conductors with a nominal cross-sectional area of 0.5 mm^2 have a current-carrying capacity of 0.5 A.

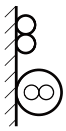
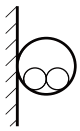
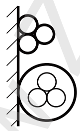
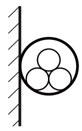
3 The current-carrying capacity is based on a cable maximum conductor operating temperature of 60°C in order to limit the surface temperatures for the expected use of such cables. Where flexible cords are used as installation wiring, the current ratings are given in Tables 4 to 15 and 17, see Clause 3.3.2.

4 To determine the three-phase voltage drop, refer to the appropriate value in Table 46, Table 47 or Table 48. To determine the single-phase voltage drop, multiply the three-phase value by 1.155.

TABLE 17
CURRENT-CARRYING CAPACITIES

CABLE TYPES: **CABLES AND FLEXIBLE CORDS**

INSULATION TYPES: **R-S-150, TYPE 150 FIBROUS OR 150°C RATED FLUOROPOLYMER**

1	2	3	4	5
Conductor size	**Current-carrying capacity, A**			
	Two single-core or one two-core		**Three or four single-core or three or four core**	
	Unenclosed in air	**Enclosed in air**	**Unenclosed in air**	**Enclosed in air**
mm²				
0.5	20	16	16	14
0.75	25	21	21	17
1.0	29	24	25	20
1.5	38	29	32	25
2.5	52	40	45	33
4	70	52	60	44
6	90	70	77	57
10	125	94	109	79
16	172	124	146	103
25	224	166	192	140
35	276	202	239	170

NOTES:

1 As a conservative alternative to cable manufacturers' recommendations, the values given in this Table may also be applied to fibrous or fluoropolymer insulated cables designed for a maximum operating temperature of 200°C.

2 No values are given in Section 4 for voltage drop for these types of cable as they are generally installed for relatively short connections to high temperature equipment. However, on longer cable runs, as the increase in conductor impedance at 150°C is considerable, it may be necessary to take voltage drop into account.

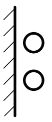
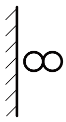
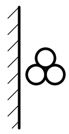
3 These ratings are based on 30°C ambient air temperature. For other conditions, see Clause 3.5.3.

TABLE 18

CURRENT-CARRYING CAPACITIES

CABLE TYPE: **BARE SINGLE-CORE MIMS CABLES WITH COPPER CONDUCTORS**

SHEATH TEMPERATURE: **100°C**

1	2	3	4	5	6	7
	Current-carrying capacity, A					
Conductor size	**Vertical spaced—spaced from wall**	**Flat horizontal—spaced from wall**	**Flat vertical—clipped to wall**	**Vertical spaced—spaced from wall**	**Trefoil—spaced from wall**	**Flat vertical—clipped to wall**
mm^2						
	0.6/0.6 kV cables					
1	23	20	18	20	18	16
1.5	27	25	22	26	22	20
2.5	38	34	30	37	30	28
4	51	46	41	48	41	37
	1/1 kV cables					
1.5	33	29	26	32	26	24
2.5	42	39	35	42	35	32
4	59	52	47	56	47	43
6	74	66	60	74	60	54
10	100	99	82	97	82	74
16	140	120	110	130	110	100
25	175	165	145	170	145	135
35	215	200	180	210	180	165
50	280	255	225	270	225	205
70	350	315	285	340	285	260
95	410	370	335	400	340	305
120	480	435	390	465	400	355
150	565	505	455	540	465	415
185	660	595	535	635	545	485
240	790	710	640	755	650	580
300	875	795	710	850	745	650
400	1090	985	885	1050	920	805

NOTES:

1 The current-carrying capacities given in this Table are based on a maximum operating temperature of 100°C for the external surface of the bare copper sheath. The current-carrying capacities of served cables may be 1.1 times higher than these if they are served with a material that is suitable for a copper sheath temperature of 105°C. See Clause 3.2.2 and Table 1 for conditions, where higher cable operating temperatures may be permitted for bare sheathed cables.

2 To determine the three-phase voltage drop, refer to the appropriate value in Table 49. To determine the single-phase voltage drop, multiply the three-phase value by 1.155.

3 The current-carrying capacities apply to single circuits. For grouped cable circuits see—

(a) Clause 3.5.2 and Tables 22 to 26 for derating factors for served cables; and

(b) Clause 3.5.2.2(a) for the treatment of unserved cables.

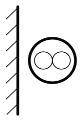
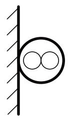
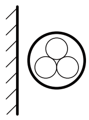
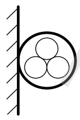
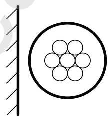
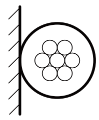
4 For earth sheath return system, temperature rises could be higher. Refer to manufacturer's instructions.

5 These ratings are based on 30°C ambient air temperature. For other conditions, see Clause 3.5.3.

TABLE 19
CURRENT-CARRYING CAPACITIES

CABLE TYPE: **BARE MULTICORE MIMS CABLES WITH COPPER CONDUCTORS**

SHEATH TEMPERATURE: 100°C

1	2	3	4	5	6	7
Conductor size	**Current-carrying capacity, A**					
	Two core—spaced from wall	**Two core—clipped to wall**	**Three and four core—spaced from wall**	**Three and four core—clipped to wall**	**Seven core—spaced from wall**	**Seven core—clipped to wall**
mm²						
0.6/0.6 kV cables						
1	19	17	17	16	12	11
1.5	25	23	21	19	16	15
2.5	34	31	29	28	22	21
4	46	43	—	—	—	—
1/1 kV cables						
1.5	29	27	24	23	18	17
2.5	38	35	32	30	24	22
4	51	47	43	41	32	30
6	66	62	55	52	—	—
10	91	84	77	73	—	—
16	125	115	105	96	—	—
25	165	155	140	135	—	—

NOTES:

1 The current-carrying capacities given in this Table are based on a maximum operating temperature of 100°C for the external surface of the bare copper sheath. The current-carrying capacities of served cables may be 1.1 times higher than these if they are served with a material which is suitable for a copper sheath temperature of 105°C. See Clause 3.2.2 and Table 1 for conditions where higher cable operating temperatures may be permitted for bare sheathed cables.

2 To determine the three-phase voltage drop, refer to the appropriate value in Table 49. To determine the single-phase voltage drop, multiply the three-phase value by 1.155.

3 The current-carrying capacities apply to single circuits. For grouped cable circuits see—

(a) Clause 3.5.2 and Tables 22 to 26 for derating factors for served cables; and

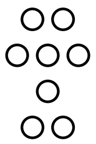
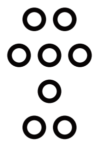
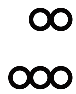
(b) Clause 3.5.2.2(a) for the treatment of unserved cables.

4 For earth sheath return system, temperature rises could be higher. Refer to manufacturer's instructions.

5 These ratings are based on 30°C ambient air temperature. For other conditions, see Clause 3.5.3.

TABLE 20
CURRENT-CARRYING CAPACITIES

CABLE TYPES: **AERIAL CABLES WITH COPPER CONDUCTORS**

1	2	3	4	5	6	7	8	9	10
Conductor size (mm²) or standing (No./mm)	**Current-carrying capacity, A**								
	Bare conductors			**PVC insulated single-core**			**PVC insulated two-core twisted, single-core neutral screened and two-core or three-core parallel-webbed cable**		
									
	Still air	**1 m/s wind**	**2 m/s wind**	**Still air**	**1 m/s wind**	**2 m/s wind**	**Still air**	**1 m/s wind**	**2 m/s wind**
7/1.00	42	84	99	—	—	—	—	—	—
6	43	87	101	40	80	90	34	57	67
7/1.25	56	111	131	—	—	—	—	—	—
10	60	120	140	55	109	124	46	78	91
16	81	158	187	74	145	165	59	103	122
7/1.75	87	169	198	—	—	—	—	—	—
7/2.00	101	198	234	—	—	—	—	—	—
25	109	212	251	100	190	218	78	137	162
35	133	258	304	122	231	264	93	165	195
7/2.75	152	293	345	—	—	—	—	—	—
50	162	310	366	148	276	315	111	197	234
19/1.75	162	310	367	—	—	—	—	—	—
19/2.00	192	366	432	—	—	—	—	—	—
70	204	389	459	187	345	396	136	247	293
7/3.50	206	393	464	—	—	—	—	—	—
7/3.75	225	429	506	—	—	—	—	—	—
95	246	467	552	226	410	471	—	—	—
37/1.75	246	467	553	—	—	—	—	—	—
19/2.75	286	540	638	—	—	—	—	—	—
120	291	548	648	267	482	553	—	—	—
19/3.00	319	602	713	—	—	—	—	—	—
150	331	624	736	304	544	622	—	—	—
185	383	716	846	355	619	709	—	—	—
37/2.50	386	723	855	—	—	—	—	—	—

(*continued*)

TABLE 20 (*continued*)

11	12	13	14	15	16	17	18	19	20
Conductor size (mm^2) or standing (No./mm)	Current-carrying capacity, A								
	PVC insulated three-core and four-core twisted and two-core, three-core or four-core neutral screened cable			XLPE insulated two-core ABC and single-core neutral screened cable			XLPE insulated three-core and four-core ABC and two-core, three-core or four-core neutral screened cable		
									
	Still air	1 m/s wind	2 m/s wind	Still air	1 m/s wind	2 m/s wind	Still air	1 m/s wind	2 m/s wind
7/1.00	—	—	—	—	—	—	—	—	—
6	30	55	64	41	64	75	36	62	71
7/1.25	—	—	—	—	—	—	—	—	—
10	41	74	87	55	88	103	50	83	96
16	54	97	114	73	115	136	66	109	127
7/1.75	—	—	—	—	—	—	—	—	—
7/2.00	—	—	—	—	—	—	—	—	—
25	72	129	152	96	154	180	88	145	169
35	87	155	182	—	—	—	—	—	—
7/2.75	—	—	—	—	—	—	—	—	—
50	105	186	219	—	—	—	—	—	—
19/1.75	—	—	—	—	—	—	—	—	—
19/2.00	—	—	—	—	—	—	—	—	—
70	131	233	276	—	—	—	—	—	—
7/3.50	—	—	—	—	—	—	—	—	—
7/3.75	—	—	—	—	—	—	—	—	—
95	—	—	—	—	—	—	—	—	—
37/1.75	—	—	—	—	—	—	—	—	—
19/2.75	—	—	—	—	—	—	—	—	—
120	—	—	—	—	—	—	—	—	—
19/3.00	—	—	—	—	—	—	—	—	—
150	—	—	—	—	—	—	—	—	—
185	—	—	—	—	—	—	—	—	—
37/2.50	—	—	—	—	—	—	—	—	—

NOTES:

1 The current-carrying capacities are based on an ambient temperature of 30°C, a maximum conductor temperature of 75°C for PVC or 80°C for XLPE, and exposure to direct sunlight having an intensity of 1000 W/m^2. In addition the values for bare conductors are based on black (weathered) conductors and the values for insulated conductors are based on the use of black PVC or XLPE.

2 Under normal circumstances there will always be some air movement and a minimum rating for 1.0 m/s wind is recommended.

3 To determine the three-phase voltage drop of these configurations, refer to the following Tables:

(a) For twisted cables, see Table 40.

(b) For parallel and webbed cables, see Table 41.

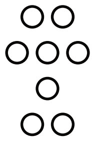
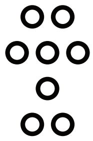
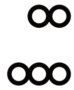
(c) For bare and single insulated cables, see Table 50.

4 These ratings are based on 30°C ambient air temperature. For other conditions, see Clause 3.5.3.

TABLE 21

CURRENT-CARRYING CAPACITIES

CABLE TYPES: **AERIAL CABLES WITH ALUMINIUM CONDUCTORS**

1	2	3	4	5	6	7	8	9	10
Conductor size (mm²) or standing (No./mm)	Current-carrying capacity, A								
	Bare conductors			PVC insulated single-core			PVC insulated two-core twisted, single-core neutral screened and two-core or three-core parallel-webbed cable		
									
	Still air	1 m/s wind	2 m/s wind	Still air	1 m/s wind	2 m/s wind	Still air	1 m/s wind	2 m/s wind
16	64	124	146	56	111	127	47	81	96
25	87	166	197	76	146	166	60	104	123
35	105	202	238	93	178	203	72	127	150
7/2.50	106	205	243	—	—	—	—	—	—
7/2.75	120	230	272	—	—	—	—	—	—
50	127	244	287	113	212	243	86	153	180
7/3.00	133	257	303	—	—	—	—	—	—
70	161	306	361	144	266	304	105	190	180
7/3.75	178	339	399	—	—	—	—	—	—
95	196	373	440	177	321	368	125	231	277
7/4.50	223	422	499	—	—	—	—	—	—
120	228	431	510	205	372	426	—	—	—
7/4.75	238	450	532	—	—	—	—	—	—
150	260	489	578	235	418	479	—	—	—
19/3.25	278	523	618	—	—	—	—	—	—
185	301	562	665	272	478	546	—	—	—
19/3.50	307	573	678	—	—	—	—	—	—

(continued)

TABLE 21 (*continued*)

11	12	13	14	15	16	17	18	19	20
Conductor size (mm²) or standing (No./mm)	**Current-carrying capacity, A**								
	PVC insulated three-core and four-core twisted and two-core, three-core or four-core neutral screened cable			**XLPE insulated two core ABC and single-core neutral screened cable**			**XLPE insulated three core and four core ABC and two-core, three-core or four- core neutral screened cable**		
	Still air	**1 m/s wind**	**2 m/s wind**	**Still air**	**1 m/s wind**	**2 m/s wind**	**Still air**	**1 m/s wind**	**2 m/s wind**
16	41	75	88	55	87	102	49	83	96
25	55	99	115	72	115	136	66	109	127
35	67	120	140	87	140	165	81	132	153
7/2.50	—	—	—	—	—	—	—	—	—
7/2.75	—	—	—	—	—	—	—	—	—
50	81	144	169	105	169	199	99	159	185
7/3.00	—	—	—	—	—	—	—	—	—
70	101	179	211	130	212	250	123	198	232
7/3.75	—	—	—	—	—	—	—	—	—
95	123	218	261	158	259	307	152	242	288
7/4.50	—	—	—	—	—	—	—	—	—
120	—	—	—	—	—	—	176	279	336
7/4.75	—	—	—	—	—	—	—	—	—
150	—	—	—	—	—	—	200	316	384
19/3.25	—	—	—	—	—	—	—	—	—
185	—	—	—	—	—	—	—	—	—
19/3.50	—	—	—	—	—	—	—	—	—

NOTES:

1 The current-carrying capacities are based on an ambient air temperature of 30°C, a maximum conductor temperature of 75°C for PVC or 80°C for XLPE, and exposure to direct sunlight having an intensity of 1000 W/m². In addition the values for bare conductors are based on black (weathered) conductors and the values for insulated conductors are based on the use of black PVC or XLPE.

2 Under normal circumstances there will always be some air movement and a minimum rating for 1.0 m/s wind is recommended.

3 To determine the three-phase voltage drop of these configurations, refer to the following Tables:

(a) For twisted cables, see Table 43.

(b) For parallel and webbed cables, see Table 44.

(c) For bare and single insulated cables, see Table 51.

4 These ratings are based on 30°C ambient air temperature. For other conditions, see Clause 3.5.3.

TABLE 22

DERATING FACTORS FOR BUNCHED CIRCUITS

CABLE TYPES: SINGLE-CORE AND MULTICORE

INSTALLATION CONDITIONS: IN AIR OR IN WIRING ENCLOSURES

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Item No.	**Arrangement of cables (see Notes 1 and 2)**		**Derating factors**														
			Number of circuits														
			1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**14**	**16**	**18**	**20 or more**
1	Bunched in air		1.00	0.87	0.75	0.72	0.70	0.67	—	—	—	—	—	—	—	—	—
2	Bunched on a surface or enclosed		1.00	0.80	0.70	0.65	0.60	0.57	0.54	0.52	0.50	0.48	0.45	0.43	0.41	0.39	0.38
3	Single layer on wall or floor	Touching	1.00	0.85	0.79	0.75	0.73	0.72	0.72	0.71	0.70	0.70	0.70	0.70	0.70	0.70	0.70
4		Spaced (see Notes 5 and 6)	1.00	0.94	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
5	Single layer under ceiling	Touching	0.95	0.81	0.72	0.68	0.66	0.64	0.63	0.62	0.61	0.61	0.61	0.61	0.61	0.61	0.61
6		Spaced (see Notes 5 and 6)	0.95	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85

NOTES:

1 Where the cable in the arrangements shown in Columns 2 and 3 consist of n loaded conductors, the conductors may be considered as—

(a) $\frac{n}{2}$ groups of two loaded conductors; or

(b) $\frac{n}{3}$ groups of three loaded conductors.

2 Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, are not taken into account when considering the number of circuits.

3 These factors are based on uniform groups of cables, equally loaded. In accordance with Clause 3.5.6 the factors for circuits subject to intermittent or varying loads may be higher.

4 These factors are applicable to numbers of circuits comprising the following:

(a) Groups of two, three or four single-core cables.

(b) Multicore cables.

(c) Cables passing more than once through the same group of cables or wiring enclosures and circuits connected in parallel in accordance with Clause 3.5.2.7.

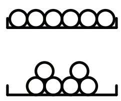
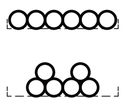
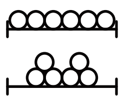
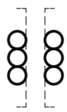
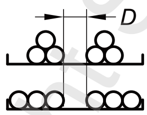
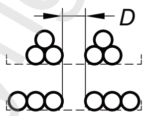
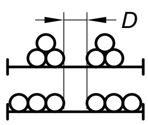
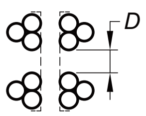
5 'Spaced' means a clearance of one cable diameter between cable surfaces of adjacent cables. Where the cables concerned are not of the same size, the spacing will be based on the largest cable diameter in the adjacent groups.

6 No derating factor is applicable for the minimum spacings specified in Clause 3.5.2.2(c) and Figure 1.

TABLE 23
DERATING FACTORS FOR CIRCUITS

CABLE TYPE: **SINGLE-CORE**

INSTALLATION CONDITIONS: **IN TRAYS, RACKS, CLEATS OR OTHER SUPPORTS IN AIR**

1	2	3	4	5	6	7	8
Item No.	**Installation**		**Number of tiers or rows of cable supports**	**Arrangements of cables in a circuit (see Note 2)**	**Derating factors**		
					Number of circuits per tier or row		
					1	**2**	**3**
1	Unperforated trays	 (See Note 6)	1	2 or 3 cables in horizontal formation	0.95	0.85	0.84
2			2		0.92	0.83	0.79
3			3		0.91	0.82	0.76
4	Perforated trays	 (See Note 6)	1	2 or 3 cables in horizontal formation	0.97	0.89	0.87
5			2		0.94	0.85	0.81
6			3		0.93	0.84	0.79
7	Ladder supports, racks and cleats	 (See Note 6)	1	2 or 3 cables in horizontal formation	1.00	0.95	0.94
8			2		0.95	0.90	0.88
9			3		0.95	0.89	0.85
10	Vertical perforated trays	 (See Note 7)	1	2 or 3 cables in vertical formation	0.94	0.85	—
11			2		0.92	0.83	—
12	Unperforated trays	 (See Note 6)	1	2 or 3 cables in horizontal formation	0.95	0.95	0.94
13			2		0.92	0.91	0.87
14			3		0.91	0.90	0.85
15	Perforated trays	 (See Note 6)	1	2 or 3 cables in horizontal formation	0.97	0.97	0.96
16			2		0.94	0.93	0.89
17			3		0.93	0.92	0.86
18	Ladder supports	 (See Note 6)	1	2 or 3 cables in horizontal formation	1.00	1.00	1.00
19			2		0.95	0.95	0.93
20			3		0.95	0.94	0.90
21	Vertical perforated trays	 (See Note 7)	1	2 or 3 cables in vertical formation	1.00	0.91	0.89
22			2		1.00	0.90	0.86

NOTES TO TABLE 23:

1 *D* equals the cable outside diameter.

2 Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be taken into account when considering the number of circuits.

3 These derating factors are to be applied to groups of two, three or four single-core cables for which the current-carrying capacity for a single circuit is obtained from Columns 5 to 7 of Tables 4, 5, 7 and 8, Columns 4 and 5 of Tables 6 and 9 and Tables 16 to 19. The factors are also applicable to groups of single-core cables making up parallel circuits in accordance with Clause 3.5.2.7.

4 These factors are based on uniform groups of cables, equally loaded. In accordance with Clause 3.5.6, the factors for circuits subject to intermittent or varying loads may be higher.

5 These factors are applicable to single layers of cables or trefoil groups, as shown in Column 2. Where there is more than one layer on the same tray or ladder support, Table 22 may be used.

6 The vertical spacing of horizontal trays and ladder supports shall be not less than 300 mm, see also Figure 1.

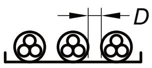
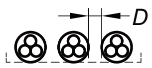
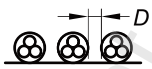
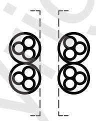
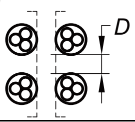
7 The horizontal spacing of vertical trays mounted back-to-back shall be not less than 230 mm.

8 No derating factor is applicable for the minimum spacings specified in Clause 3.5.2.2(c) and Figure 1(a).

TABLE 24
DERATING FACTORS FOR CIRCUITS

CABLE TYPE: **MULTICORE**

INSTALLATION CONDITIONS: **IN TRAYS, RACKS, CLEATS OR OTHER SUPPORTS IN AIR**

1	2	3	4	5	6	7	8	9	10
Item No.	**Installation**		**Number of tiers or rows of cable supports**	**Derating factors**					
				Number of cables					
				1	**2**	**3**	**4**	**6**	**9**
1	Unperforated trays		1	0.97	0.85	0.78	0.75	0.71	0.68
2		Touching (see Note 6)	2	0.97	0.84	0.76	0.73	0.68	0.63
3			3	0.97	0.83	0.75	0.72	0.66	0.61
4			1	0.97	0.96	0.94	0.93	0.90	—
5			2	0.97	0.95	0.92	0.90	0.86	—
6		Spaced (see Note 6)	3	0.97	0.94	0.91	0.89	0.84	—
7	Perforated trays		1	1.00	0.88	0.82	0.78	0.76	0.73
8		Touching (see Note 6)	2	1.00	0.87	0.80	0.76	0.73	0.68
9			3	1.00	0.86	0.79	0.75	0.71	0.66
10			1	1.00	1.00	0.98	0.95	0.91	—
11			2	1.00	0.99	0.96	0.92	0.87	—
12		Spaced (see Note 6)	3	1.00	0.98	0.95	0.91	0.85	—
13	Ladder supports, racks and cleats		1	1.00	0.87	0.82	0.80	0.79	0.78
14		Touching (see Note 6)	2	1.00	0.86	0.80	0.78	0.76	0.73
15			3	1.00	0.85	0.79	0.76	0.73	0.70
16			1	1.00	1.00	1.00	1.00	1.00	—
17			2	1.00	0.99	0.98	0.97	0.96	—
18		Spaced (see Note 6)	3	1.00	0.98	0.97	0.96	0.93	—
19	Vertical perforated trays		1	1.00	0.88	0.82	0.77	0.73	0.72
20		Touching (see Note 7)	2	1.00	0.88	0.81	0.76	0.72	0.70
21			1	1.00	0.91	0.89	0.88	0.87	—
22		Spaced (see Note 7)	2	1.00	0.91	0.88	0.87	0.86	—

NOTES TO TABLE 24:

1 *D* equals the cable outside diameter or in the case of a flat multicore cable the maximum dimension of the cable.

2 Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be taken into account when considering the number of circuits.

3 These derating factors are to be applied to groups of multicore cables for which the current-carrying capacity for a single circuit is obtained from Columns 2 to 4 of Tables 10, 11, 13 and 14, Columns 2 and 3 of Tables 12 and 15 and Tables 16 to 19. The factors are also applicable to groups of multicore cables making up parallel circuits in accordance with Clause 3.5.2.7.

4 These factors are applicable to uniform groups of cables, equally loaded. In accordance with Clause 3.5.6 the factors for circuits subject to intermittent or varying loads may be higher.

5 These factors are applicable to single layers of cables as shown in Column 2. Where there is more than one layer on the same tray or ladder support, Table 22 may be used.

6 The vertical spacing of horizontal trays and ladder supports shall be not less than 300 mm.

7 The horizontal spacing of vertical trays mounted back-to-back shall be not less than 230 mm.

8 No derating factor is applicable for the minimum spacings specified in Clause 3.5.2.2(c) and Figure 1(b).

TABLE 25(1)

DERATING FACTORS FOR GROUPS OF CIRCUITS

CABLE TYPE: **SINGLE-CORE**

INSTALLATION CONDITIONS: **BURIED DIRECT IN GROUND**

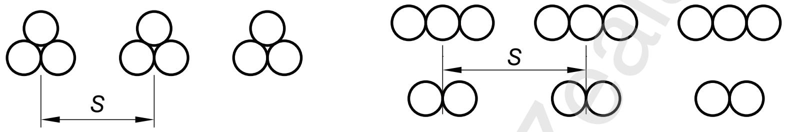
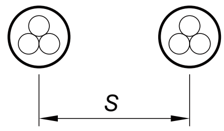
1	2	3	4	5	6	7
Number of circuits						
	Derating factors					
	Touching		**Distance (S), m**			
	Trefoil	**Laid flat**	**0.15**	**0.30**	**0.45**	**0.60**
2	0.78	0.81	0.83	0.88	0.91	0.93
3	0.66	0.70	0.73	0.79	0.84	0.87
4	0.61	0.64	0.68	0.74	0.81	0.85
5	0.56	0.60	0.64	0.73	0.79	0.83
6	0.53	0.57	0.61	0.71	0.78	0.82
7	0.50	0.54	0.59	0.69	0.76	0.82
8	0.49	0.53	0.57	0.68	0.76	0.81
9	0.47	0.51	0.56	0.67	0.75	0.81
10	0.46	0.50	0.55	0.67	0.75	0.80
11	0.44	0.49	0.54	0.66	0.74	0.80
12	0.43	0.48	0.53	0.66	0.74	0.80

TABLE 25(2)

DERATING FACTORS FOR GROUPS OF CIRCUITS

CABLE TYPE: **MULTICORE**

INSTALLATION CONDITIONS: **BURIED DIRECT IN GROUND**

1	**2**	**3**	**4**	**5**	**6**
Number of cables in group					
	Derating factors				
	Touching	**Distance (S), m**			
		0.15	**0.30**	**0.45**	**0.60**
2	0.81	0.87	0.91	0.93	0.95
3	0.70	0.78	0.84	0.88	0.90
4	0.63	0.74	0.81	0.86	0.89
5	0.59	0.70	0.78	0.84	0.87
6	0.55	0.68	0.77	0.83	0.87
7	0.52	0.66	0.75	0.82	0.86
8	0.50	0.64	0.75	0.81	0.86
9	0.48	0.63	0.74	0.81	0.85
10	0.47	0.62	0.73	0.80	0.85
11	0.45	0.61	0.73	0.80	0.85
12	0.44	0.60	0.72	0.80	0.84

NOTES:

1 For derating factors applicable to other arrangements of single-core and multicore cables laid direct in the ground, refer to ERA Report 69-30 or alternative specifications.

2 The derating factors have been determined from the hottest cable in the group and assume that all cables are of the same thermal grade of insulation.

TABLE 26(1)

DERATING FACTORS FOR GROUPS OF CIRCUITS

CABLE TYPE: **SINGLE-CORE**

INSTALLATION CONDITIONS: **IN UNDERGROUND WIRING ENCLOSURES—ENCLOSED SEPARATELY**

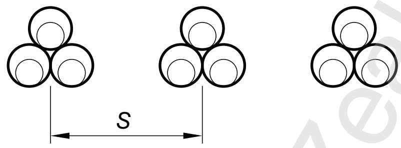
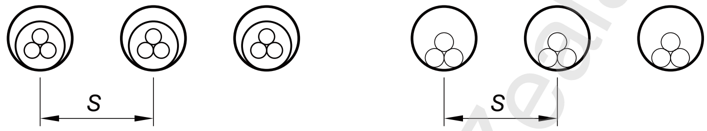
1	2	3	4
Number of circuits			
	Derating factor		
	Touching	**Distance (S), m**	
		0.45	**0.60**
2	0.87	0.91	0.93
3	0.78	0.84	0.87
4	0.74	0.81	0.85
5	0.70	0.79	0.83
6	0.69	0.78	0.82
7	0.67	0.76	0.82
8	0.66	0.76	0.81
9	0.65	0.75	0.81
10	0.64	0.75	0.80
11	0.63	0.74	0.80
12	0.63	0.74	0.80

TABLE 26(2)

DERATING FACTORS FOR GROUPS OF CIRCUITS

CABLE TYPES: **SINGLE-CORE OR MULTICORE**

INSTALLATION CONDITIONS: **IN UNDERGROUND WIRING ENCLOSURES—MULTICORE CABLES ENCLOSED SEPARATELY OR MORE THAN ONE SINGLE-CORE CABLE PER WIRING ENCLOSURE**



1	2	3	4	5
Number of circuits	**Derating factor**			
	Touching	**Distance (S), m**		
		0.30	**0.45**	**0.60**
2	0.90	0.93	0.95	0.96
3	0.83	0.88	0.91	0.93
4	0.79	0.85	0.89	0.92
5	0.75	0.83	0.88	0.91
6	0.73	0.82	0.87	0.90
7	0.71	0.81	0.86	0.89
8	0.70	0.80	0.85	0.89
9	0.68	0.79	0.85	0.89
10	0.67	0.79	0.85	0.89
11	0.66	0.78	0.84	0.88
12	0.66	0.78	0.84	0.88

NOTE: For derating factors applicable to other arrangements of cables in underground wiring enclosures, refer to ERA Report 69-30 or alternative specifications.

TABLE 27(1)
RATING FACTORS

VARIANCE: AIR AND CONCRETE SLAB AMBIENT TEMPERATURES

INSTALLATION CONDITIONS: CABLES IN AIR OR HEATED CONCRETE SLABS

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
Conductor temperature °C	Rating factor																				
	Air and concrete slab ambient temperature (see Notes 1, 2 and 3), °C																				
	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	100	110	120	130	140
150	1.07	1.05	1.03	1.00	0.98	0.96	0.94	0.91	0.89	0.87	0.85	0.82	0.80	0.77	0.74	0.71	0.66	0.58	0.50	0.41	0.29
110	1.08	1.06	1.03	1.00	0.97	0.93	0.90	0.87	0.83	0.79	0.75	0.71	0.66	0.61	0.56	0.50	0.36	—	—	—	—
90	1.15	1.09	1.05	1.00	0.95	0.91	0.85	0.80	0.74	0.66	0.59	0.52	0.43	0.31	0.17	—	—	—	—	—	—
80	1.17	1.12	1.06	1.0	0.95	0.89	0.82	0.75	0.68	0.59	0.50	0.40	0.24	—	—	—	—	—	—	—	—
75	1.18	1.12	1.06	1.0	0.94	0.88	0.80	0.72	0.63	0.53	0.43	0.32	—	—	—	—	—	—	—	—	—

NOTES:

1 For heated concrete slabs, the ambient temperature shall be taken as the operating temperature of the slab.

2 The normal usage of high temperature insulation cables is in ambient air temperatures greater than 30°C, see Table 17.

3 For cables with a maximum permissible operating temperature above the normal use temperatures specified in Tables 3(1), 3(2), 3(3) and 3(4), derating may not be necessary, see Notes to Table 1 for further details.

TABLE 27(2)
RATING FACTORS

VARIANCE: SOIL AMBIENT TEMPERATURE

INSTALLATION CONDITIONS: CABLES BURIED DIRECT IN GROUND OR IN UNDERGROUND WIRING ENCLOSURES

1	2	3	4	5	6	7	8
Conductor temperature °C	Rating factor						
	Soil ambient temperature, °C						
	10	15	20	25	30	35	40
110	1.02	1.00	0.97	0.95	0.92	0.89	0.86
90	1.04	1.00	0.96	0.93	0.91	0.87	0.83
80	1.04	1.00	0.95	0.92	0.88	0.83	0.78
75	1.04	1.00	0.95	0.91	0.86	0.81	0.75

TABLE 28(1)
RATING FACTORS

CABLE TYPES: SINGLE-CORE OR MULTICORE

VARIANCE: DEPTH OF LAYING

INSTALLATION CONDITIONS: BURIED DIRECT IN GROUND

1	2	3	4
Depth of laying	Rating factor		
	Conductor size, mm²		
m	Up to 50	Above 50 up to 300	Above 300
0.5	1.00	1.00	1.00
0.6	0.99	0.98	0.97
0.8	0.97	0.96	0.94
1.0	0.95	0.94	0.92
1.25	0.94	0.92	0.90
1.5	0.93	0.91	0.89
1.75	0.92	0.89	0.87
2.0	0.91	0.88	0.86
2.5	0.90	0.87	0.85
3.0 or more	0.89	0.86	0.83

NOTE: The ambient temperature at the surface is to be taken at 30°C and not 15°C as at a depth of 0.5 m.

TABLE 28(2)
RATING FACTORS

CABLE TYPES: SINGLE-CORE OR MULTICORE

VARIANCE: DEPTH OF LAYING

INSTALLATION CONDITIONS: IN UNDERGROUND WIRING ENCLOSURES

1	2	3
Depth of laying	Rating factor	
m	Single-core*	Multicore
0.5	1.00	1.00
0.6	0.98	0.99
0.8	0.95	0.97
1.0	0.93	0.96
1.25	0.90	0.95
1.5	0.89	0.94
1.75	0.88	0.94
2.0	0.87	0.93
2.5	0.86	0.93
3.0 or more	0.85	0.92

* These rating factors apply to single-core cables enclosed separately, or grouped in a single wiring enclosure.

NOTE: The ambient temperature at the surface is to be taken as 30°C and not 15°C as at a depth of 0.5 m. For depth less than 0.5 m, see Table 3(4).

TABLE 29

RATING FACTORS

VARIANCE: **THERMAL RESISTIVITY OF THE SOIL (FROM 1.2°C.m/W)**

INSTALLATION CONDITIONS: **BURIED DIRECT IN GROUND AND IN UNDERGROUND WIRING ENCLOSURES**

1	2	3	4	5	6
	Rating factor				
Thermal resistivity of soil °C.m/W	Multicore cable buried direct	Two or three single-core cables buried direct	Multicore cable in a wiring enclosure	Two single-core cables in a wiring enclosure*	Three single-core cables in a wiring enclosure*
0.8	1.09	1.16	1.03	1.06	1.08
0.9	1.07	1.11	1.02	1.04	1.06
1.0	1.04	1.07	1.02	1.03	1.04
1.2	1.00	1.00	1.00	1.00	1.00
1.5	0.92	0.90	0.95	0.94	0.92
2.0	0.81	0.80	0.88	0.86	0.83
2.5	0.74	0.72	0.83	0.80	0.77
3.0	0.69	0.66	0.78	0.75	0.71

* These rating factors apply to single-core cables enclosed separately, or grouped in a single wiring enclosure.

NOTE: See Clause 3.5.5 for additional information on thermal resistivity of soil.

SECTION 4 VOLTAGE DROP

4.1 GENERAL

The provisions of this Section apply to the selection of conductor sizes with regard to voltage drop.

NOTE: AS/NZS 3000 imposes limitations on circuit arrangements in order to restrict excessive voltage drop between supply and load.

Clauses 4.2 and 4.3 describe a simplified method of determining the voltage drop for use with Tables 40 to 51 for applications where only the route length and load current of balanced circuits are known.

Clauses 4.4 and 4.5 describe a more accurate method of determining the voltage drop for use with Tables 30 to 39 where the cable size is known or anticipated.

Clause 4.6 describes a method for determining the voltage drop where unbalanced load current conditions occur.

4.2 DETERMINATION OF VOLTAGE DROP FROM MILLIVOLTS PER AMPERE METRE

The voltage drop (mV/A.m) values given in Tables 40 to 51 are for various cable types and configurations and maximum operating temperatures.

In applying these voltage drop values, the smallest permissible conductor is the smallest that satisfies the following equations:

$$V_c = \frac{1000 V_d}{L \times I} \qquad \text{. . . 4.2(1)}$$

$$V_d = \frac{L \times I \times V_c}{1000} \qquad \text{. . . 4.2(2)}$$

$V_p \geq$ sum of V_d on circuit run

where

V_c = the millivolt drop per ampere—metre route length of circuit, as shown in the Tables for various conductors, in millivolts per ampere metre (mV/A.m)

NOTES:

1 To convert single-phase voltage drop (mV/A.m) values to three-phase values, multiply the single-phase values by 0.866 $\left(\frac{\sqrt{3}}{2}\right)$. To convert three-phase values to single-phase values, multiply the three-phase values buy 1.155 $\left(\frac{2}{\sqrt{3}}\right)$.

2 Paragraph C4 and Table C7 of AS/NZS 3000:2007 details a simplified method of calculating the voltage drop for PVC cables up to 95 mm^2, operating at 75°C with maximum values of V_c. The method allows the addition of single phase and three phase percentages.

V_d = actual voltage drop, in volts

V_p = permissible voltage drop on the circuit run, e.g. 5% of supply voltage, in volts

L = route length of circuit, in metres

I = the current to be carried by the cable, in amperes

The voltage drop values in Tables 40 to 51 may not be applicable under the following conditions:

(a) Where the cable operating temperature is lower than the maximum temperature permitted for the insulation material. See Clause 4.4 for a method of determining the cable operating temperature for use with the tables.

(b) Where the load power factor and cable power factor do not give rise to conditions for maximum voltage drop, or the load power factor for larger size conductors varies from 0.8 lagging. See Clause 4.5 for a method of determining the voltage drop where other power factor values are known to be consistent.

(c) Where out-of-balance load conditions exist. See Clause 4.6 for a method of determining the actual voltage drop on a circuit where out-of-balance loads are known to be consistent.

4.3 DETERMINATION OF VOLTAGE DROP FROM CIRCUIT IMPEDANCE

4.3.1 General

Voltage drop in a circuit represents the vectorial difference in voltage between the origin or supply end and the load end. For the purpose of determining the maximum voltage drop value in Clause 4.2, the voltage drop (V_d) has been related to the impedance of the cables forming the circuit when the power factor of the cable is equal to the power factor of the load, in which case—

$$V_d = IZ_c \qquad \text{. . . 4.3(1)}$$

where

V_d = voltage drop in cable, in volts

I = current flowing in cable, in amperes

Z_c = impedance of cable, in ohms

= $\sqrt{(R^2{}_c + X^2{}_c)}$

R_c = cable resistance, in ohms; a function of the material, size and temperature of the conductors

X_c = cable reactance, in ohms; a function of the conductor shape and cable spacing

= 0, for direct current conditions

The reactance X_c and resistance R_c of cables is expressed in this Standard as ohms per kilometre, which enables the total impedance Z_c for any given cable route length L to be readily calculated.

Therefore, the maximum volt drop in a cable, when the power factor of the cable is equal to the power factor of the load is obtained by multiplying the cable impedance Z_c by the length of cable and the current as follows:

$$V_d = \frac{ILZ_c}{1000} \qquad \text{. . . 4.3(2)}$$

where

L = route length, in metres, see Clause 1.5.6

V_d = voltage drop in cable, in volts

Z_c = impedance of cable, in ohms/km

4.3.2 Single-phase, two-wire supply system

For a single-phase circuit the impedance of the active and neutral conductors is taken into account. As these conductors are of the same material and generally the same size, the voltage drop on the circuit is twice what it would be for a single cable—

$$V_{\mathrm{d}1\varphi} = \frac{ILZ_{\mathrm{c}}}{1000} \text{ or } \frac{IL(2Z_{\mathrm{c}})}{1000} \qquad \ldots 4.3(3)$$

4.3.3 Three-phase, three-wire or four-wire supply system

For a balanced three-phase circuit no current is flowing in the neutral conductor and at any given instant the current flowing in one active conductor will be balanced by the currents flowing in the other active conductors. The voltage drop per phase to neutral is the voltage drop in one cable and the voltage drop between phases is therefore—

$$V_{\mathrm{d}3\varphi} = \frac{\sqrt{3}\, ILZ_{\mathrm{c}}}{1000} \text{ or } \frac{IL(\sqrt{3}Z_{\mathrm{c}})}{1000} \qquad \ldots 4.3(4)$$

As the single-phase voltage drop (mV/A.m.) values represent $2Z_{\mathrm{c}}$ and the three-phase voltage drop (mV/A.m.) values represent $\sqrt{3}Z_{\mathrm{c}}$, then the following conversions may be used:

(a) Single-phase voltage drop (mV/A.m.) value = 1.155 × three-phase voltage drop (mV/A.m.) value.

(b) Three-phase voltage drop (mV/A.m.) value = 0.866 × single-phase voltage drop (mV/A.m.) value.

4.3.4 Two-phase, three-wire, earthed neutral 120-degree supply system

For a balanced two-phase circuit of this type the current flowing in the neutral conductor will balance the currents flowing in the active conductors. The voltage drop may be assessed on a single-phase basis by summing the voltage drop in one active conductor (Is) with the in-phase component of voltage drop in the neutral ($0.5IZ_{\mathrm{c}}$), i.e.—

$$\begin{aligned} V_{\mathrm{d}} &= \frac{ILZ_{\mathrm{c}} + 0.5\, ILZ_{\mathrm{c}}}{1000} \\ &= \frac{1.5\,(ILZ_{\mathrm{c}})}{1000} \\ &= 0.75\, V_{\mathrm{d}1\phi} \end{aligned} \qquad \ldots 4.3(5)$$

4.3.5 Single-phase, three-wire, earthed centre-tapped 180-degree supply system

For a balanced single-phase circuit of this type no current is flowing in the neutral or centre-tapped conductor. Therefore the voltage drop on a single-phase basis will only be that associated with the current flowing in one active conductor, i.e.—

$$\begin{aligned} V_{\mathrm{d}} &= \frac{ILZ_{\mathrm{c}}}{1000} \\ &= 0.5V_{\mathrm{d}1\phi} \end{aligned} \qquad \ldots 4.3(6)$$

4.4 DETERMINATION OF VOLTAGE DROP FROM CABLE OPERATING TEMPERATURE

As described in Clause 3.2.2 and Table 1 of this Standard, the sustained cable current-carrying capacities given in Tables 4 to 19 are based on cables operating at the maximum conductor temperature permitted by the cable insulation material when installed in specified ambient conditions. In many situations, however, the cable operating temperature is considerably less than the maximum figure. Some situations where this will occur are as follows:

(a) Cables sizes are selected in order not to exceed a certain voltage drop figure.

(b) Cable sizes are selected for convenience, mechanical strength or short-circuit capacity as required by AS/NZS 3000.

(c) The ambient air or soil temperatures are consistently below the specified or standard conditions.

The conductor temperature can be estimated using the following equation:

$$\left(\frac{I_0}{I_R}\right)^2 = \frac{\theta_0 - \theta_A}{\theta_R - \theta_A} \qquad \text{. . . 4.4}$$

where

I_0 = operating current, in amperes

I_R = rated current given in Tables 4 to 21, in amperes

(For cable affected by the presence of certain external influences as detailed in Clauses 3.5.2 to 3.5.8, it will be necessary to correct the rated current given in Tables 4 to 21 by the application of an appropriate rating factor or factors obtained from Tables 22 to 29.)

θ_0 = operating temperature of cable when carrying I_0, in degrees Celsius

θ_R = operating temperature of the cable when carrying I_R, in degrees Celsius

θ_A = ambient air or soil temperature, in degrees Celsius

The calculated operating temperature (θ_0) is then raised to the nearest temperature 45°C, 60°C, 75°C, 80°C, 90°C or 110°C for use with Tables 34 to 50 to determine the cable a.c. resistance and three-phase voltage drop.

NOTE: An example of the application of this method is provided in Appendix A, Paragraph A6.

4.5 DETERMINATION OF VOLTAGE DROP FROM LOAD POWER FACTOR

The relationship between the supply and load voltages under different conditions of load power factor is illustrated in the phasor diagrams of Figure 2.

From the phasor diagrams of Figure 2 it can be seen that a larger value of supply voltage is required to maintain a given load voltage when the current is lagging the voltage than when the same current and voltage are in phase. Furthermore, a still smaller supply voltage is required to maintain the given load voltage when the current leads the load voltage.

The voltage drop (*Is*) is the same in all cases, but because of the different power factors the voltage (*Is*) is added to the load voltage at a different angle in each case. It can be seen that in the particular instance where the cable power factor and the load power factor are equal, the voltage drop (V_d) is a maximum of *Is* as discussed in Clause 4.3.

In other situations of load power factor the difference between the magnitudes of the supply voltage (E) and the load voltage (V_L) is smaller. It will be noted that the magnitude of the phasors IR_c and IX_c has been exaggerated with respect to V_L in Figure 2 to illustrate the point. In practice the voltage drop is very much smaller than the supply voltage and the difference between the magnitudes of the supply and load voltages may be approximated by the following equation:

$$E - V_L = I\left(R_c \cos\theta + X_c \sin\theta\right) \text{ for lagging p.f.} \quad \ldots 4.5(1)$$

$$= I\left(R_c \cos\theta - X_c \sin\theta\right) \text{ for leading p.f.} \quad \ldots 4.5(2)$$

Therefore, for a single-phase system:

$$V_{d1\varphi} = IL\left[2\left(R_c \cos\theta + X_c \sin\theta\right)\right] \quad \ldots 4.5(3)$$

And a three-phase system:

$$V_{d3\phi} = IL\left[\sqrt{3}(R_c \cos\theta + X_c \sin\theta)\right] \quad \ldots 4.5(4)$$

where

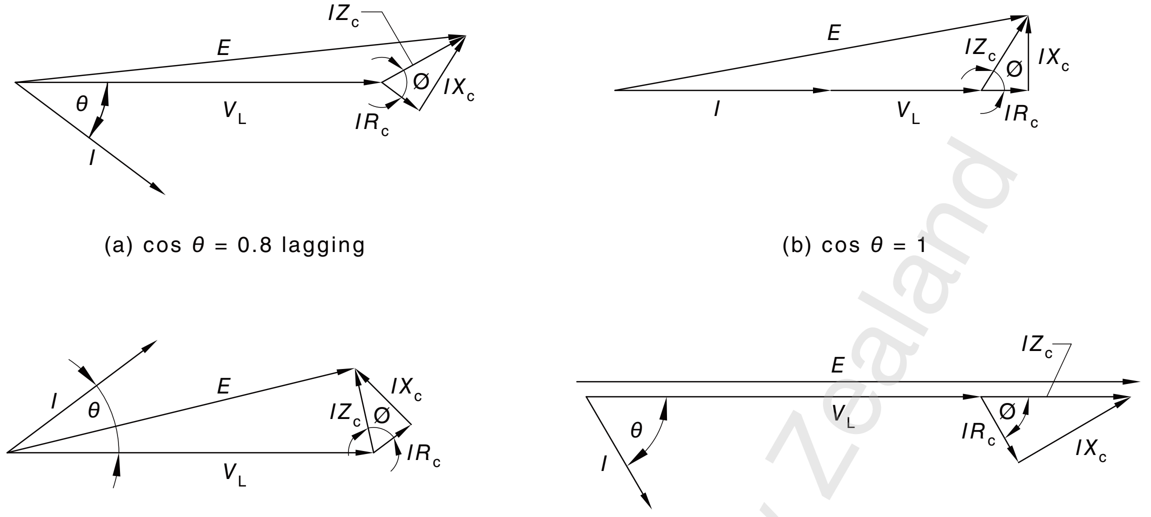
L = route length of circuit, in metres

R_c = cable resistance, in ohms per metre

X_c = cable reactance, in ohms per metre

Values of R_c and X_c are given in units of ohms per kilometre (Ω/km) in Tables 30 to 39. It will be noted that the influence of skin effect on resistance has been taken into account in the specification of cable resistance values in Tables 34 to 39 and as such are referred to as values of a.c. resistance.

NOTE: An example of the application of this method is provided in Appendix A, Paragraph A7.



(a) cos θ = 0.8 lagging

(b) cos θ = 1

(c) cos θ = 0.8 leading

(d) cos θ = cos Ø (maximum voltage drop condition)

LEGEND:

I = current flowing in cable

E = voltage at supply

V_L = voltage at load

V_d = $E - V_L$

IZ_c = voltage drop associated with the impedance of the cable

= $I\sqrt{(R_c^2 + R_c^2)}$

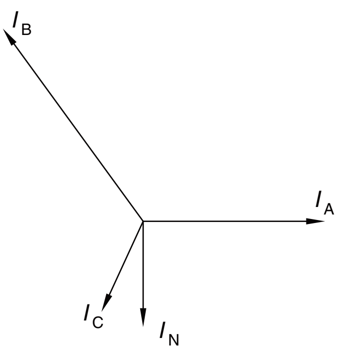
cos θ = power factor of load

cos Ø = power factor of cable

FIGURE 2 PHASOR DIAGRAMS ILLUSTRATING VOLTAGE DROP VARIATION WITH LOAD POWER FACTOR

4.6 DETERMINATION OF VOLTAGE DROP IN UNBALANCED MULTIPHASE CIRCUITS

For unbalanced multiphase circuits, current will be flowing in the neutral conductor as illustrated in the phasor diagram of Figure 3.



$I_A + I_B + I_C + I_N = 0$

FIGURE 3 PHASOR DIAGRAM OF CURRENTS IN UNBALANCED THREE-PHASE CIRCUIT

A conservative solution to the voltage drop assessment in these situations would be to assume balanced three-phase load conditions and perform calculations using the current flowing in the heaviest-loaded phase. In many cases this will still be necessary if the out-of-balance conditions are inconsistent or intermittent.

However, where the currents in each phase can be shown to be of different magnitudes for consistent periods, voltage drop calculations can be performed on a single-phase basis by geometrically summing the voltage drop in the heaviest loaded phase and the voltage drop in the neutral, as follows:

$$V_d = \text{voltage drop in heaviest loaded active} + \text{voltage drop in neutral}$$

$$= I_A L_A Z_{cA} + I_N L_N Z_{cN} \qquad \ldots 4.6$$

The voltage drop in each conductor can then be assessed with a knowledge of the specific conductor material, size, temperature and length, the magnitude and phase angle of the current flowing in each conductor, and the phase angle of the load by using the appropriate equations given in this Clause.

TABLE 30
REACTANCE (X_c) AT 50 Hz

CABLE TYPE: ALL CABLES INCLUDING ABC* BUT EXCLUDING FLEXIBLE CORDS, FLEXIBLE CABLES, MIMS CABLES AND AERIAL CABLES

1	2	3	4	5	6	7	8	9	10	11	12
Conductor size	Reactance (X_c) at 50 Hz, Ω/km										
	Single-core (see Notes 1 to 3)						Multicore				
	Trefoil (or single phase)			Flat touching (see Note 4)			Circular conductors			Shaped conductors	
mm²	Elastomer	PVC	XLPE	Elastomer	PVC	XLPE	Elastomer	PVC	XLPE	PVC	XLPE
1	0.179	0.168	0.166	0.194	0.184	0.181	0.139	0.119	0.114	—	—
1.5	0.167	0.157	0.155	0.183	0.172	0.170	0.129	0.111	0.107	—	—
2.5	0.153	0.143	0.141	0.168	0.159	0.156	0.118	0.102	0.0988	—	—
4	0.142	0.137	0.131	0.157	0.152	0.146	0.110	0.102	0.0930	—	—
6	0.133	0.128	0.123	0.148	0.143	0.138	0.104	0.0967	0.0887	—	—
10	0.123	0.118	0.114	0.138	0.134	0.129	0.0967	0.0906	0.0840	—	—
16	0.114	0.111	0.106	0.130	0.126	0.122	0.0913	0.0861	0.0805	0.0794	0.0742
25	0.109	0.106	0.102	0.125	0.121	0.118	0.0895	0.0853	0.0808	0.0786	0.0744
35	0.104	0.101	0.0982	0.120	0.117	0.113	0.0863	0.0826	0.0786	0.0761	0.0725
50	0.0988	0.0962	0.0924	0.114	0.111	0.108	0.0829	0.0797	0.0751	0.0734	0.0692
70	0.0941	0.0917	0.0893	0.109	0.107	0.104	0.0798	0.0770	0.0741	0.0710	0.0683
95	0.0924	0.0904	0.0868	0.108	0.106	0.102	0.0790	0.0766	0.0725	0.0706	0.0668
120	0.0889	0.0870	0.0844	0.104	0.102	0.0996	0.0765	0.0743	0.0713	0.0685	0.0657
150	0.0885	0.0868	0.0844	0.104	0.102	0.0996	0.0765	0.0745	0.0718	0.0687	0.0662
185	0.0878	0.0862	0.0835	0.103	0.101	0.0988	0.0762	0.0744	0.0720	0.0686	0.0663
240	0.0861	0.0847	0.0818	0.101	0.0999	0.0970	0.0751	0.0735	0.0709	0.0678	0.0653
300	0.0852	0.0839	0.0809	0.100	0.0991	0.0961	0.0746	0.0732	0.0704	0.0675	0.0649
400	0.0841	0.0829	0.0802	0.0993	0.0982	0.0955	0.0740	0.0728	0.0702	0.0671	0.0647
500	0.0830	0.0820	0.0796	0.0983	0.0973	0.0948	0.0734	0.0723	0.0700	0.0666	0.0645
630	0.0809	0.0800	0.0787	0.0961	0.0952	0.0940	—	—	—	—	—

* For ABC and other twisted aerial cables, see Columns 3 and 4.

NOTES:

1 These reactance values should only be applied for single-core cables installed strictly in touching formation. Where single-core cables are spaced apart a correction factor to the reactance value should be applied according to the magnitude of the cable spacing, e.g. where cables are spaced apart with 0.5*D*, 1*D* or 2*D* separation distances add 0.0254 ohm/km, 0.0435 ohm/km or 0.0690 ohm/km, respectively, to the values in Column 2 to Column 7:

where

D = diameter of single-core cable.

2 For single-core cables in single-way ducts, *D* in NOTE 1 is the diameter of the single-core cable, i.e. not the diameter of the duct.

3 A correction factor is not required for cable sizes less than 25 mm² that are spaced up to 5*D* apart as the impact on voltage drop is less than 2.5% and can be ignored.

4 These reactance values may also be used as a conservative estimate for cables that are not strictly arranged 'flat touching', e.g. where cables are installed in a common wiring enclosure.

TABLE 31

REACTANCE (X_c) AT 50 Hz

CABLE TYPES: FLEXIBLE CORDS AND FLEXIBLE CABLES

1	2	3	4	5	6	7	8	9	10
Conductor size	Reactance (X_c) at 50 Hz, Ω/km								
	Single-core (see Notes 1 to 3)						Multicore		
	Trefoil (or single phase)			Flat touching (see Note 4)			Circular conductors		
mm²	Elastomer	PVC	XLPE	Elastomer	PVC	XLPE	Elastomer	PVC	XLPE
0.5	0.192	0.180	0.178	0.207	0.195	0.193	0.153	0.131	0.125
0.75	0.179	0.168	0.166	0.194	0.183	0.181	0.142	0.122	0.117
1	0.171	0.161	0.158	0.186	0.176	0.173	0.136	0.116	0.111
1.5	0.160	0.150	0.148	0.176	0.165	0.163	0.127	0.109	0.105
2.5	0.149	0.139	0.137	0.164	0.155	0.153	0.118	0.101	0.0977
4	0.137	0.132	0.126	0.152	0.147	0.141	0.108	0.100	0.0911
6	0.129	0.124	0.119	0.144	0.139	0.134	0.103	0.0954	0.0871
10	0.116	0.112	0.107	0.131	0.127	0.123	0.0936	0.0876	0.0810
16	0.109	0.105	0.101	0.124	0.120	0.116	0.0887	0.0835	0.0779
25	0.104	0.1010	0.0973	0.119	0.116	0.113	0.0871	0.0829	0.0783
35	0.0991	0.0961	0.0930	0.114	0.111	0.108	0.0839	0.0801	0.0761
50	0.0964	0.0938	0.0901	0.112	0.109	0.105	0.0832	0.0799	0.0754
70	0.0917	0.0894	0.0869	0.107	0.105	0.102	0.0800	0.0773	0.0744
95	0.0905	0.0885	0.0849	0.106	0.104	0.100	0.0796	0.0771	0.0729
120	0.0872	0.0854	0.0828	0.102	0.101	0.0980	0.0774	0.0753	0.0723
150	0.0870	0.0853	0.0830	0.102	0.101	0.0982	0.0775	0.0755	0.0728
185	0.0862	0.0847	0.0821	0.101	0.0999	0.0973	0.0771	0.0754	0.0730
240	0.0849	0.0835	0.0808	0.100	0.0988	0.0960	0.0764	0.0749	0.0722
300	0.0842	0.0830	0.0800	0.0994	0.0982	0.0953	0.0761	0.0747	0.0718
400	0.0825	0.0814	0.0788	0.0977	0.0966	0.0941	0.0750	0.0738	0.0714
500	0.0812	0.0803	0.0780	0.0965	0.0955	0.0932	0.0743	0.0732	0.0711
630	0.0797	0.0789	0.0777	0.0950	0.0941	0.0929	—	—	—

NOTES:

1 These reactance values should only be applied for single-core cables installed strictly in touching formation. Where single-core cables are spaced apart a correction factor to the reactance value should be applied according to the magnitude of the cable spacing, e.g. where cables are spaced apart with 0.5*D*, 1*D* or 2*D* separation distances add 0.0254 ohm/km, 0.0435 ohm/km or 0.0690 ohm/km, respectively, to the values in Column 2 to Column 7:

where

D = diameter of single-core cable.

2 For single-core cables in single-way ducts, *D* in NOTE 1 is the diameter of the single-core cable, i.e. not the diameter of the duct.

3 A correction factor is not required for cable sizes less than 25 mm² that are spaced up to 5*D* apart as the impact on voltage drop is less than 2.5% and can be ignored.

4 These reactance values may also be used as a conservative estimate for cables that are not strictly arranged 'flat touching', e.g. where cables are installed in a common wiring enclosure.

TABLE 32
REACTANCE (X_c) AT 50 Hz

CABLE TYPE: **MIMS**

Conductor size mm²	Reactance (X_c) at 50 Hz, Ω/km	
	Single-core (trefoil formation)	Multicore
0.6/0.6 kV cables		
1	0.123	0.0912
1.5	0.116	0.0865
2.5	0.107	0.0814
4	0.101	—
1/1 kV cables		
1.5	0.139	0.1010
2.5	0.128	0.0937
4	0.120	0.0879
6	0.112	0.0835
10	0.104	0.0788
16	0.0976	0.0752
25	0.0927	0.0723
35	0.0889	—
50	0.0854	—
70	0.0827	—
95	0.0804	—
120	0.0785	—
150	0.0772	—
185	0.0784	—
240	0.0768	—
300	0.0777	—
400	0.0784	—

TABLE 33

REACTANCE (X_c) AT 50 Hz

CABLE TYPE: SINGLE-CORE AERIAL WITH BARE OR INSULATED CONDUCTORS

Conductor size (mm²) or stranding (No./mm)	Reactance (X_c) of 50 Hz, Ω/km*	
	Single phase and trefoil	Three cores in flat formation
7/1.00	0.371	0.385
6	0.368	0.383
7/1.25	0.357	0.371
10	0.352	0.366
16	0.337	0.352
7/1.75	0.336	0.350
7/2.00	0.327	0.342
25	0.317	0.332
35	0.309	0.324
7/2.50	0.313	0.328
7/2.75	0.307	0.322
50	0.300	0.314
19/1.75	0.301	0.315
7/3.00	0.302	0.316
19/2.00	0.292	0.307
70	0.288	0.303
7/3.50	0.292	0.307
7/3.75	0.288	0.302
95	0.278	0.292
37/1.75	0.279	0.293
7/4.50	0.276	0.291
19/2.75	0.272	0.287
120	0.270	0.284
7/4.75	0.273	0.287
19/3.00	0.267	0.282
150	0.263	0.278
19/3.25	0.262	0.276
185	0.256	0.271
19/3.50	0.257	0.272
37/2.50	0.257	0.271

* Values are based on a spacing of 0.4 m.

TABLE 34
a.c. RESISTANCE (R_c) AT 50 Hz

CABLE TYPE: SINGLE-CORE

1	2	3	4	5	6	7	8	9	10	11	12
Conductor size	a.c. resistance (R_c) at 50 Hz, Ω/km										
	Copper*						Aluminium				
	Conductor temperature, °C						Conductor temperature, °C				
mm²	45	60	75	80	90	110	45	60	75	80	90
1	23.3	24.5	25.8	—	27.0	28.7	—	—	—	—	—
1.5	14.9	15.7	16.5	—	17.3	18.4	—	—	—	—	—
2.5	8.14	8.57	9.01	—	9.45	10.0	—	—	—	—	—
4	5.06	5.33	5.61	—	5.88	6.24	—	—	—	—	—
6	3.38	3.56	3.75	3.81	3.93	4.17	—	—	—	—	—
10	2.01	2.12	2.23	2.26	2.33	2.48	—	—	—	—	—
16	1.26	1.33	1.40	1.42	1.47	1.56	2.10	2.22	2.33	2.37	2.45
25	0.799	0.842	0.884	0.899	0.927	0.984	1.32	1.39	1.47	1.49	1.54
35	0.576	0.607	0.638	—	0.668	0.710	0.956	1.01	1.06	1.08	1.11
50	0.426	0.448	0.471	—	0.494	0.524	0.706	0.745	0.783	0.796	0.822
70	0.295	0.311	0.327	—	0.342	0.363	0.488	0.515	0.542	0.551	0.568
95	0.213	0.225	0.236	—	0.247	0.262	0.353	0.372	0.392	0.398	0.411
120	0.170	0.179	0.188	—	0.197	0.208	0.279	0.295	0.310	0.315	0.325
150	0.138	0.145	0.153	—	0.160	0.169	0.228	0.240	0.253	0.257	0.265
185	0.111	0.117	0.123	—	0.129	0.136	0.182	0.192	0.202	–	0.212
240	0.0862	0.0905	0.0948	—	0.0991	0.105	0.140	0.147	0.155	—	0.162
300	0.0703	0.0736	0.0770	—	0.0803	0.0846	0.113	0.119	0.125	—	0.130
400	0.0569	0.0595	0.0620	—	0.0646	0.0677	0.0890	0.0936	0.0981	—	0.103
500	0.0467	0.0487	0.0506	—	0.0525	0.0547	0.0709	0.0744	0.0779	—	0.0813
630	0.0389	0.0404	0.0418	—	0.0432	0.0448	0.0571	0.0597	0.0623	—	0.0649

* For the a.c. resistance of tinned copper conductor, multiply copper value by 1.01.

TABLE 35

a.c. RESISTANCE (R_c) AT 50 Hz

CABLE TYPE: MULTICORE WITH CIRCULAR CONDUCTORS

1	2	3	4	5	6	7	8	9	10
Conductor size	a.c. resistance (R_c) at 50 Hz, Ω/km								
	Copper*					Aluminium			
	Conductor temperature, °C					Conductor temperature, °C			
mm²	45	60	75	90	110	45	60	75	90
1	23.3	24.5	25.8	27.0	28.7	—	—	—	—
1.5	14.9	15.7	16.5	17.3	18.4	—	—	—	—
2.5	8.14	8.57	9.01	9.45	10.0	—	—	—	—
4	5.06	5.33	5.61	5.88	6.24	—	—	—	—
6	3.38	3.56	3.75	3.93	4.17	—	—	—	—
10	2.01	2.12	2.23	2.33	2.48	—	—	—	—
16	1.26	1.33	1.40	1.47	1.56	2.10	2.22	2.33	2.45
25	0.799	0.842	0.884	0.927	0.984	1.32	1.39	1.47	1.54
35	0.576	0.607	0.638	0.669	0.710	0.956	1.01	1.06	1.11
50	0.426	0.449	0.471	0.494	0.524	0.706	0.745	0.784	0.822
70	0.295	0.311	0.327	0.343	0.364	0.488	0.515	0.542	0.569
95	0.214	0.225	0.236	0.248	0.262	0.353	0.373	0.392	0.411
120	0.170	0.179	0.188	0.197	0.209	0.280	0.295	0.310	0.325
150	0.139	0.146	0.153	0.160	0.170	0.228	0.241	0.253	0.265
185	0.112	0.118	0.123	0.129	0.136	0.182	0.192	0.202	0.212
240	0.0870	0.0912	0.0955	0.0998	0.105	0.140	0.148	0.155	0.162
300	0.0712	0.0745	0.0778	0.0812	0.0852	0.113	0.119	0.125	0.131
400	0.0580	0.0605	0.0630	0.0656	0.0685	0.0897	0.0943	0.0988	0.103
500	0.0486	0.0506	0.0525	0.0544	0.0565	0.0730	0.0765	0.0800	0.0835

* For the a.c. resistance of tinned copper conductor, multiply copper value by 1.01.

TABLE 36

a.c. RESISTANCE (R_c) AT 50 Hz

CABLE TYPE: **MULTICORE WITH SHAPED CONDUCTORS**

1	2	3	4	5	6	7	8	9
Conductor size	a.c. resistance (R_c) at 50 Hz, Ω/km							
	Copper*				Aluminium			
	Conductor temperature, °C				Conductor temperature, °C			
mm²	45	60	75	90	45	60	75	90
16	1.26	1.33	1.40	1.47	2.10	2.22	2.33	2.45
25	0.799	0.842	0.884	0.927	1.32	1.39	1.47	1.54
35	0.576	0.607	0.638	0.669	0.956	1.01	1.06	1.11
50	0.426	0.448	0.471	0.494	0.706	0.745	0.783	0.822
70	0.295	0.311	0.327	0.342	0.488	0.515	0.542	0.568
95	0.213	0.224	0.236	0.247	0.353	0.372	0.392	0.411
120	0.170	0.179	0.187	0.196	0.279	0.295	0.310	0.325
150	0.138	0.145	0.153	0.160	0.228	0.240	0.253	0.265
185	0.111	0.117	0.123	0.128	0.182	0.192	0.202	0.211
240	0.0859	0.0902	0.0945	0.0988	0.139	0.147	0.154	0.162
300	0.0698	0.0732	0.0766	0.0800	0.112	0.118	0.124	0.130
400	0.0563	0.0589	0.0615	0.0641	0.0886	0.0932	0.0978	0.102
500	0.0466	0.0486	0.0506	0.0526	0.0716	0.0752	0.0788	0.0824

* For the a.c. resistance of tinned copper conductor, multiply copper value by 1.01.

TABLE 37

a.c. RESISTANCE (R_c) AT 50 Hz

CABLE TYPES: FLEXIBLE CORDS AND FLEXIBLE CABLES WITH COPPER CONDUCTORS*

1	2	3	4	5	6	7	8	9	10	11
Conductor size	a.c. resistance (R_c) at 50 Hz, Ω/km									
	Single-core					Multicore				
	Conductor temperature, °C					Conductor temperature, °C				
mm²	45	60	75	90	110	45	60	75	90	110
0.5	42.8	45.1	47.4	49.7	52.8	42.8	45.1	47.4	49.7	52.8
0.75	28.6	30.1	31.6	33.2	35.2	28.6	30.1	31.6	33.2	35.2
1	21.4	22.6	23.7	24.9	26.4	21.4	22.6	23.7	24.9	26.4
1.5	14.6	15.4	16.2	17.0	18.0	14.6	15.4	16.2	17.0	18.0
2.5	8.76	9.23	9.70	10.2	10.8	8.76	9.23	9.70	10.2	10.8
4	5.44	5.73	6.02	6.31	6.70	5.44	5.73	6.02	6.31	6.70
6	3.62	3.82	4.01	4.21	4.47	3.62	3.82	4.01	4.21	4.47
10	2.10	2.21	2.32	2.44	2.59	2.10	2.21	2.32	2.44	2.59
16	1.33	1.40	1.47	1.54	1.64	1.33	1.40	1.47	1.54	1.64
25	0.857	0.903	0.949	0.995	1.06	0.857	0.903	0.949	0.995	1.06
35	0.609	0.641	0.674	0.707	0.750	0.609	0.642	0.674	0.707	0.750
50	0.424	0.447	0.470	0.493	0.523	0.425	0.447	0.470	0.493	0.523
70	0.300	0.316	0.332	0.348	0.369	0.300	0.316	0.332	0.348	0.369
95	0.227	0.240	0.252	0.264	0.280	0.228	0.240	0.252	0.264	0.280
120	0.178	0.188	0.197	0.207	0.219	0.179	0.188	0.198	0.207	0.219
150	0.144	0.151	0.159	0.166	0.176	0.144	0.152	0.159	0.167	0.176
185	0.119	0.125	0.131	0.137	0.145	0.119	0.126	0.132	0.138	0.146
240	0.0912	0.0958	0.100	0.105	0.111	0.0920	0.0965	0.101	0.106	0.111
300	0.0745	0.0780	0.0817	0.0853	0.0898	0.0753	0.0789	0.0825	0.0860	0.0905
400	0.0587	0.0613	0.0640	0.0666	0.0699	0.0597	0.0623	0.0649	0.0675	0.0706
500	0.0487	0.0507	0.0527	0.0548	0.0571	0.0498	0.0518	0.0538	0.0558	0.0580
630	0.0395	0.0409	0.0424	0.0438	0.0455					

* For the a.c. resistance of tinned copper conductors, multiply copper value by 1.01.

TABLE 38

a.c. RESISTANCE (R_c) AT 50 Hz

CABLE TYPE: **MIMS**

1	2	3	4	5	6	7
Conductor size	a.c. resistance (R_c) at 50 Hz, Ω/km					
	Conductor temperature, °C					
mm²	45	60	75	90	100	105
1	18.9	19.9	20.9	21.9	22.6	22.9
1.5	12.7	13.3	14.0	14.7	15.2	15.4
2.5	7.61	8.02	8.43	8.83	9.11	9.24
4	4.76	5.02	5.27	5.53	5.70	5.78
6	3.16	3.33	3.50	3.67	3.79	3.84
10	1.89	1.99	2.09	2.20	2.26	2.30
16	1.19	1.25	1.31	1.38	1.42	1.44
25	0.758	0.799	0.840	0.880	0.907	0.921
35	0.541	0.570	0.599	0.628	0.647	0.657
50	0.379	0.400	0.420	0.440	0.454	0.460
70	0.271	0.286	0.300	0.315	0.325	0.329
95	0.201	0.211	0.222	0.233	0.240	0.243
120	0.160	0.168	0.176	0.185	0.190	0.193
150	0.129	0.135	0.142	0.149	0.153	0.155
185	0.105	0.110	0.116	0.121	0.125	0.127
240	0.0825	0.0866	0.0906	0.0947	0.0975	0.0988
300	0.0674	0.0706	0.0739	0.0771	0.0792	0.0803
400	0.0527	0.550	0.0574	0.0597	0.0613	0.0621

TABLE 39

a.c. RESISTANCE (R_c) AT 50 Hz

CABLE TYPE: SINGLE-CORE AERIAL WITH BARE OR INSULATED CONDUCTORS

1	2	3	4	5	6	7	8	9
Conductor size (mm^2) or stranding (No./mm)	a.c. resistance (R_c) at 50 Hz, Ω/km*							
	Copper				Aluminium			
	Conductor temperature, °C				Conductor temperature, °C			
	45	60	75	80	45	60	75	80
7/1.00	3.57	3.76	3.95	4.02	—	—	—	—
6	3.48	3.67	3.86	3.92	—	—	—	—
7/1.25	2.30	2.42	2.54	2.58	—	—	—	—
10	2.06	2.18	2.29	2.32	—	—	—	—
16	1.30	1.37	1.44	1.46	2.10	2.21	2.32	2.36
7/1.75	1.16	1.23	1.29	1.31	—	—	—	—
7/2.00	0.895	0.943	0.991	1.01	—	—	—	—
25	0.823	0.867	0.911	0.926	1.32	1.39	1.46	1.48
35	0.593	0.625	0.657	0.667	0.953	1.00	1.06	1.07
7/2.50	—	—	—	—	0.915	0.964	1.01	1.03
7/2.75	0.476	0.501	0.527	0.535	0.757	0.797	0.838	0.852
50	0.438	0.462	0.485	0.493	0.704	0.742	0.780	0.792
19/1.75	0.434	0.457	0.481	0.488	—	—	—	—
7/3.00	—	—	—	—	0.636	0.670	0.704	0.716
19/2.00	0.333	0.351	0.369	0.375	—	—	—	—
70	0.303	0.320	0.336	0.341	0.487	0.513	0.539	0.548
7/3.50	0.295	0.310	0.326	0.331	—	—	—	—
7/3.75	0.256	0.270	0.284	0.288	0.407	0.428	0.450	0.457
95	0.226	0.238	0.250	0.254	0.352	0.371	0.389	0.396
37/1.75	0.223	0.235	0.247	0.251	—	—	—	—
7/4.50	—	—	—	—	0.284	0.299	0.314	0.319
19/2.75	0.176	0.186	0.195	0.198	—	—	—	—
120	0.174	0.183	0.193	0.196	0.278	0.293	0.308	0.313
7/4.75	—	—	—	—	0.255	0.269	0.282	0.287
19/3.00	0.148	0.156	0.163	0.166	—	—	—	—
150	0.141	0.149	0.156	0.159	0.227	0.239	0.251	0.255
19/3.25	—	—	—	—	0.201	0.212	0.223	0.227
185	0.113	0.119	0.125	0.127	0.181	0.190	0.200	0.203
19/3.50	—	—	—	—	0.173	0.182	0.191	0.194
37/2.50	0.110	0.116	0.122	0.124	—	—	—	—

* Values are based on a spacing of 0.4 m.

TABLE 40

THREE-PHASE VOLTAGE DROP (V_c) AT 50 Hz

CABLE TYPES: **SINGLE-CORE INSULATED AND SHEATHED COPPER CONDUCTORS LAID IN TREFOIL**

1	2	3	4	5	6	7	8	9	10	11	12	13
Conductor size	Three-phase voltage drop (V_c) at 50 Hz, mV/A.m											
	Conductor temperature, °C											
	45		60		75		80 (see Note 3)		90		110	
mm²	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.
1	40.3	40.3	42.5	42.5	44.7	44.7	—	—	46.8	46.8	49.7	49.7
1.5	25.9	25.9	27.3	27.3	28.6	28.6	—	—	30.0	30.0	31.9	31.9
2.5	14.1	14.1	14.9	14.9	15.6	15.6	—	—	16.4	16.4	17.4	17.4
4	8.77	8.77	9.24	9.24	9.71	9.71	—	—	10.2	10.2	10.8	10.8
6	5.86	5.86	6.18	6.18	6.49	6.49	6.60	6.60	6.81	6.81	7.23	7.23
10	3.49	3.49	3.67	3.67	3.86	3.86	3.92	3.92	4.05	4.05	4.30	4.30
16	2.20	2.20	2.31	2.31	2.43	2.43	2.47	2.47	2.55	2.55	2.70	2.70
25	1.40	1.40	1.47	1.47	1.54	1.54	1.57	1.57	1.62	1.62	1.72	1.72
35	1.01	1.01	1.07	1.07	1.12	1.12	—	—	1.17	1.17	1.24	1.24
50	0.757	0.757	0.795	0.795	0.834	0.834	—	—	0.872	0.872	0.924	0.924
70	0.537	0.537	0.563	0.563	0.589	0.589	—	—	0.615	0.615	0.650	0.650
95	0.402	0.402	0.420	0.420	0.439	0.439	—	—	0.457	0.457	0.481	0.481
120	0.332	0.332	0.345	0.345	0.359	0.359	—	—	0.373	0.373	0.392	0.392
150	0.284	0.284	0.295	0.295	0.305	0.305	—	—	0.316	0.316	0.331	0.331
185	0.245	0.245	0.253	0.253	0.261	0.261	—	—	0.269	0.269	0.280	0.280
240	0.211	0.208	0.216	0.214	0.221	0.220	—	—	0.227	0.226	0.235	0.234
300	0.191	0.185	0.195	0.190	0.198	0.195	—	—	0.202	0.199	0.208	0.206
400	0.175	0.166	0.178	0.169	0.181	0.173	—	—	0.183	0.176	0.187	0.181
500	0.165	0.150	0.166	0.153	0.168	0.156	—	—	0.170	0.158	0.172	0.162
630	0.155	0.138	0.156	0.140	0.157	0.142	—	—	0.159	0.144	0.160	0.146

NOTES:

1 These V_c values apply to a balanced three-phase circuit in which no current flows in the neutral conductor. To determine the single phase V_c the current in the neutral conductor needs to be considered by multiplying the three-phase value by $\frac{2}{\sqrt{3}} = 1.155$.

2 These V_c values should only be applied for single-core cables installed strictly in touching formation. Where single-core cables are spaced apart or in single-way ducts the V_c shall be calculated using the impedance of the cable, see Clause 4.3, and using the revised value of reactance as detailed in footnote to Tables 30 and 31.

(These V_c values may be used for cable sizes less than 25 mm² that are spaced up to 5*D* apart as the impact on V_c is less than 2.5% and can be ignored.)

3 These V_c values apply also to aerial bundled cables (ABC).

TABLE 41

THREE-PHASE VOLTAGE DROP (V_c) AT 50 Hz

CABLE TYPES: SINGLE-CORE INSULATED AND SHEATHED COPPER CONDUCTORS, LAID FLAT TOUCHING OR TOUCHING INSIDE A COMMON WIRING ENCLOSURE

1	2	3	4	5	6	7	8	9	10	11
Conductor size	Three-phase voltage drop (V_c) at 50 Hz, mV/A.m									
	Conductor temperature, °C									
	45		60		75		90		110	
mm²	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.
1	40.3	40.3	42.5	42.5	44.7	44.7	46.8	46.8	49.7	49.7
1.5	25.9	25.9	27.3	27.3	28.6	28.6	30.0	30.0	31.9	31.9
2.5	14.1	14.1	14.9	14.9	15.6	15.6	16.4	16.4	17.4	17.4
4	8.77	8.77	9.24	9.24	9.71	9.71	10.2	10.2	10.8	10.8
6	5.86	5.86	6.18	6.18	6.49	6.49	6.81	6.81	7.23	7.23
10	3.49	3.49	3.68	3.68	3.86	3.86	4.05	4.05	4.30	4.30
16	2.20	2.20	2.32	2.32	2.43	2.43	2.55	2.55	2.71	2.71
25	1.40	1.40	1.47	1.47	1.55	1.55	1.62	1.62	1.72	1.72
35	1.02	1.02	1.07	1.07	1.12	1.12	1.18	1.18	1.25	1.25
50	0.763	0.763	0.801	0.801	0.840	0.840	0.878	0.878	0.929	0.929
70	0.545	0.545	0.571	0.571	0.597	0.597	0.623	0.623	0.657	0.657
95	0.413	0.413	0.431	0.431	0.449	0.449	0.467	0.467	0.491	0.491
120	0.345	0.345	0.358	0.358	0.371	0.371	0.385	0.385	0.403	0.403
150	0.299	0.299	0.309	0.309	0.319	0.319	0.330	0.330	0.344	0.344
185	0.262	0.261	0.270	0.269	0.277	0.277	0.285	0.285	0.296	0.296
240	0.230	0.224	0.235	0.230	0.240	0.236	0.245	0.242	0.252	0.250
300	0.212	0.201	0.215	0.206	0.219	0.211	0.222	0.215	0.227	0.222
400	0.198	0.181	0.200	0.185	0.202	0.189	0.205	0.192	0.208	0.197
500	0.188	0.166	0.190	0.169	0.191	0.172	0.193	0.174	0.195	0.178
630	0.179	0.153	0.180	0.155	0.181	0.157	0.182	0.159	0.184	0.162

NOTES:

1 These V_c values apply to a balanced three-phase circuit in which no current flows in the neutral conductor. To determine the single phase V_c the current in the neutral conductor needs to be considered by multiplying the three-phase value by $\frac{2}{\sqrt{3}} = 1.155$.

2 These V_c values should only be applied for single-core cables installed strictly in touching formation. Where single-core cables are spaced apart, e.g. in separate wiring enclosures, the V_c shall be calculated using the impedance of the cable, see Clause 4.3, and using the revised value of reactance as detailed in footnote to Tables 30 and 31.

(These V_c values may be used for cable sizes less than 25 mm² that are spaced up to 5*D* apart as the impact on V_c is less than 2.5% and can be ignored.)

TABLE 42

THREE-PHASE VOLTAGE DROP (V_c) AT 50 Hz

CABLE TYPE: MULTICORE WITH CIRCULAR COPPER CONDUCTORS

1	2	3	4	5	6	7	8	9	10	11
Conductor size	Three-phase voltage drop (V_c) at 50 Hz, mV/A.m									
	Conductor temperature, °C									
	45		60		75		90		110	
mm^2	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.
1	40.3	40.3	42.5	42.5	44.7	44.7	46.8	46.8	49.7	49.7
1.5	25.9	25.9	27.3	27.3	28.6	28.6	30.0	30.0	31.9	31.9
2.5	14.1	14.1	14.9	14.9	15.6	15.6	16.4	16.4	17.4	17.4
4	8.77	8.77	9.24	9.24	9.71	9.71	10.2	10.2	10.8	10.8
6	5.86	5.86	6.18	6.18	6.49	6.49	6.80	6.80	7.22	7.22
10	3.49	3.49	3.67	3.67	3.86	3.86	4.05	4.05	4.29	4.29
16	2.19	2.19	2.31	2.31	2.43	2.43	2.55	2.55	2.70	2.70
25	1.39	1.39	1.47	1.47	1.54	1.54	1.61	1.61	1.71	1.71
35	1.01	1.01	1.06	1.06	1.11	1.11	1.17	1.17	1.24	1.24
50	0.751	0.751	0.790	0.790	0.829	0.829	0.868	0.868	0.920	0.920
70	0.530	0.530	0.556	0.556	0.583	0.583	0.609	0.609	0.645	0.645
95	0.394	0.394	0.413	0.413	0.431	0.431	0.450	0.450	0.475	0.475
120	0.323	0.323	0.337	0.337	0.351	0.351	0.366	0.366	0.385	0.385
150	0.274	0.274	0.285	0.285	0.296	0.296	0.307	0.307	0.322	0.322
185	0.234	0.234	0.242	0.242	0.251	0.251	0.259	0.259	0.271	0.271
240	0.198	0.198	0.204	0.204	0.210	0.210	0.216	0.216	0.224	0.224
300	0.178	0.175	0.182	0.180	0.186	0.185	0.190	0.189	0.196	0.196
400	0.162	0.157	0.165	0.160	0.168	0.164	0.171	0.167	0.175	0.172
500	0.152	0.143	0.154	0.146	0.156	0.148	0.158	0.151	0.160	0.155

NOTE: These V_c values apply to a balanced three-phase circuit in which no current flows in the neutral conductor. To determine the single phase V_c the current in the neutral conductor needs to be considered by multiplying the three-phase value by $\frac{2}{\sqrt{3}} = 1.155$.

TABLE 43

THREE-PHASE VOLTAGE DROP (V_c) AT 50 Hz

CABLE TYPES: SINGLE-CORE INSULATED AND SHEATHED ALUMINIUM CONDUCTORS, LAID IN TREFOIL

1	2	3	4	5	6	7	8	9	10	11
Conductor size	Three-phase voltage drop (V_c) at 50 Hz, mV/A.m									
	Conductor temperature, °C									
	45		60		75		80 (see Note 3)		90	
mm^2	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.
16	3.65	3.65	3.85	3.85	4.05	4.05	4.11	4.11	4.25	4.25
25	2.30	2.30	2.42	2.42	2.55	2.55	2.59	2.59	2.67	2.67
35	1.66	1.66	1.75	1.75	1.85	1.85	1.88	1.88	1.94	1.94
50	1.23	1.23	1.30	1.30	1.37	1.37	1.39	1.39	1.43	1.43
70	0.860	0.860	0.906	0.906	0.952	0.952	0.966	0.966	0.997	0.997
95	0.631	0.631	0.663	0.663	0.696	0.696	0.706	0.706	0.727	0.727
120	0.507	0.507	0.532	0.532	0.558	0.558	0.565	—	0.582	0.582
150	0.422	0.422	0.443	0.443	0.463	0.463	0.468	—	0.482	0.482
185	0.349	0.349	0.364	0.364	0.380	0.380	—	—	0.394	0.394
240	0.283	0.283	0.294	0.294	0.305	0.305	—	—	0.314	0.314
300	0.243	0.243	0.251	0.251	0.260	0.260	—	—	0.266	0.266
400	0.211	0.209	0.216	0.216	0.222	0.222	—	—	0.226	0.226
500	0.188	0.183	0.192	0.188	0.196	0.193	—	—	0.197	0.195
630	0.170	0.162	0.173	0.166	0.175	0.169	—	—	0.177	0.172

NOTES:

1 These V_c values apply to a balanced three-phase circuit in which no current flows in the neutral conductor. To determine the single phase V_c the current in the neutral conductor needs to be considered by multiplying the three-phase value by $\frac{2}{\sqrt{3}} = 1.155$.

2 These V_c values should only be applied for single-core cables installed strictly in touching formation. Where single-core cables are spaced apart or in single-way ducts the V_c shall be calculated using the impedance of the cable, see Clause 4.3, and using the revised value of reactance as detailed in footnote to Tables 30 and 31.

(These V_c values may be used for cable sizes less than 25 mm^2 that are spaced up to 5*D* apart as the impact on V_c is less than 2.5% and can be ignored.)

3 These V_c values apply also to aerial bundled cables (ABC).

TABLE 44

THREE-PHASE VOLTAGE DROP (V_c) AT 50 Hz

CABLE TYPES: **SINGLE-CORE INSULATED AND SHEATHED ALUMINIUM CONDUCTORS, LAID FLAT TOUCHING OR TOUCHING INSIDE A COMMON WIRING ENCLOSURE**

1	2	3	4	5	6	7	8	9
Conductor size	Three-phase voltage drop (V_c) at 50 Hz, mV/A.m							
	Conductor temperature, °C							
	45		60		75		90	
mm²	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.
16	3.65	3.65	3.85	3.85	4.05	4.05	4.25	4.25
25	2.30	2.30	2.42	2.42	2.55	2.55	2.67	2.67
35	1.67	1.67	1.76	1.76	1.85	1.85	1.94	1.94
50	1.24	1.24	1.30	1.30	1.37	1.37	1.44	1.44
70	0.866	0.866	0.911	0.911	0.956	0.956	1.00	1.00
95	0.638	0.638	0.670	0.670	0.702	0.702	0.733	0.733
120	0.515	0.515	0.540	0.540	0.565	0.565	0.589	0.589
150	0.432	0.432	0.452	0.452	0.472	0.472	0.491	0.491
185	0.361	0.361	0.376	0.376	0.391	0.391	0.404	0.404
240	0.297	0.297	0.308	0.308	0.319	0.319	0.327	0.327
300	0.260	0.259	0.268	0.267	0.276	0.275	0.281	0.281
400	0.229	0.225	0.235	0.231	0.240	0.238	0.243	0.242
500	0.208	0.199	0.212	0.204	0.216	0.209	0.216	0.211
630	0.192	0.178	0.195	0.181	0.197	0.185	0.198	0.188

NOTES:

1 These V_c values apply to a balanced three-phase circuit in which no current flows in the neutral conductor. To determine the single phase V_c the current in the neutral conductor needs to be considered by multiplying the three-phase value by $\frac{2}{\sqrt{3}} = 1.155$.

2 These V_c values should only be applied for single-core cables installed strictly in touching formation. Where single-core cables are spaced apart, e.g. in separate wiring enclosures, the V_c shall be calculated using the impedance of the cable, see Clause 4.3, and using the revised value of reactance as detailed in footnote to Tables 30 and 31.

(These V_c values may be used for cable sizes less than 25 mm² that are spaced up to 5*D* apart as the impact on V_c is less than 2.5% and can be ignored.)

TABLE 45

THREE-PHASE VOLTAGE DROP (V_c) AT 50 Hz

CABLE TYPE: MULTICORE CABLES WITH CIRCULAR ALUMINIUM CONDUCTORS

1	2	3	4	5	6	7	8	9
Conductor size	Three-phase voltage drop (V_c) at 50 Hz, mV/A.m							
	Conductor temperature, °C							
	45		60		75		90	
mm^2	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.
16	3.64	3.64	3.84	3.84	4.04	4.04	4.24	4.24
25	2.29	2.29	2.42	2.42	2.54	2.54	2.67	2.67
35	1.66	1.66	1.75	1.75	1.84	1.84	1.93	1.93
50	1.23	1.23	1.30	1.30	1.36	1.36	1.43	1.43
70	0.856	0.856	0.902	0.902	0.948	0.948	0.993	0.993
95	0.626	0.626	0.659	0.659	0.691	0.691	0.723	0.723
120	0.501	0.501	0.527	0.527	0.552	0.552	0.577	0.577
150	0.416	0.416	0.436	0.436	0.457	0.457	0.476	0.476
185	0.341	0.341	0.357	0.357	0.373	0.373	0.388	0.388
240	0.274	0.274	0.285	0.285	0.297	0.297	0.307	0.307
300	0.233	0.233	0.242	0.242	0.251	0.251	0.258	0.258
400	0.200	0.200	0.206	0.206	0.212	0.212	0.216	0.216
500	0.178	0.176	0.182	0.181	0.186	0.185	0.189	0.189

NOTES:

1 For aerial bundled cables (ABC) use XLPE single-core, trefoil figures.

2 These V_c values apply to a balanced three-phase circuit in which no current flows in the neutral conductor. To determine the single phase V_c the current in the neutral conductor needs to be considered by multiplying the three-phase value by $\frac{2}{\sqrt{3}} = 1.155$.

TABLE 46

THREE-PHASE VOLTAGE DROP (V_c) AT 50 Hz

CABLE TYPES: SINGLE-CORE FLEXIBLE CORDS AND FLEXIBLE CABLES, LAID IN TREFOIL

1	2	3	4	5	6	7	8	9	10	11
Conductor size	**Three-phase voltage drop (V_c) at 50 Hz, mV/A.m**									
	Conductor temperature, °C									
	45		**60**		**75**		**90**		**110**	
mm^2	**Max.**	**0.8 p.f.**	**Max.**	**0.8 p.f.**	**Max.**	**0.8 p.f.**	**Max.**	**0.8 p.f.**	**Max.**	**0.8 p.f.**
0.5	74.2	74.2	78.2	78.2	82.2	82.2	86.1	86.1	91.4	91.4
0.75	49.5	49.5	52.1	52.1	54.8	54.8	57.4	57.4	61.0	61.0
1	37.1	37.1	39.1	39.1	41.1	41.1	43.1	43.1	45.7	45.7
1.5	25.3	25.3	26.7	26.7	28.0	28.0	29.4	29.4	31.2	31.2
2.5	15.2	15.2	16.0	16.0	16.8	16.8	17.6	17.6	18.7	18.7
4	9.42	9.42	9.92	9.92	10.4	10.4	10.9	10.9	11.6	11.6
6	6.28	6.28	6.62	6.62	6.95	6.95	7.29	7.29	7.74	7.74
10	3.64	3.64	3.83	3.83	4.03	4.03	4.22	4.22	4.48	4.48
16	2.31	2.31	2.43	2.43	2.56	2.56	2.68	2.68	2.84	2.84
25	1.50	1.50	1.57	1.57	1.65	1.65	1.73	1.73	1.84	1.84
35	1.07	1.07	1.12	1.12	1.18	1.18	1.24	1.24	1.31	1.31
50	0.754	0.754	0.792	0.792	0.831	0.831	0.869	0.869	0.921	0.921
70	0.543	0.543	0.569	0.569	0.596	0.596	0.622	0.622	0.658	0.658
95	0.424	0.424	0.443	0.443	0.463	0.463	0.483	0.483	0.509	0.509
120	0.344	0.344	0.358	0.358	0.373	0.373	0.388	0.388	0.408	0.408
150	0.291	0.291	0.302	0.302	0.313	0.313	0.325	0.325	0.340	0.340
185	0.254	0.254	0.263	0.263	0.272	0.272	0.280	0.280	0.293	0.293
240	0.215	0.214	0.221	0.221	0.227	0.227	0.233	0.233	0.242	0.242
300	0.194	0.190	0.198	0.195	0.203	0.200	0.207	0.205	0.213	0.212
400	0.175	0.166	0.178	0.170	0.180	0.174	0.183	0.178	0.187	0.183
500	0.164	0.151	0.165	0.154	0.167	0.157	0.169	0.160	0.172	0.164
630	0.154	0.137	0.155	0.139	0.156	0.141	0.157	0.143	0.159	0.146

NOTES:

1 These V_c values apply to a balanced three-phase circuit in which no current flows in the neutral conductor. To determine the single phase V_c the current in the neutral conductor needs to be considered by multiplying the three-phase value by $\frac{2}{\sqrt{3}} = 1.155$.

2 These V_c values should only be applied for single-core cables installed strictly in touching formation. Where single-core cables are spaced apart or in single-way ducts the V_c shall be calculated using the impedance of the cable, see Clause 4.3, and using the revised value of reactance as detailed in footnote to Tables 30 and 31.

(These V_c values may be used for cable sizes less than 25 mm^2 that are spaced up to 5*D* apart as the impact on V_c is less than 2.5% and can be ignored.)

TABLE 47

THREE-PHASE VOLTAGE DROP (V_c) AT 50 Hz

CABLE TYPES: **SINGLE-CORE FLEXIBLE CORDS AND FLEXIBLE CABLES, LAID FLAT TOUCHING OR TOUCHING INSIDE A COMMON WIRING ENCLOSURE**

1	2	3	4	5	6	7	8	9	10	11
Conductor size	Three-phase voltage drop (V_c) at 50 Hz, mV/A.m									
	Conductor temperature, °C									
	45		60		75		90		110	
mm²	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.
0.5	74.2	74.2	78.2	78.2	82.2	82.2	86.1	86.1	91.4	91.4
0.75	49.5	49.5	52.1	52.1	54.8	54.8	57.4	57.4	61.0	61.0
1	37.1	37.1	39.1	39.1	41.1	41.1	43.1	43.1	45.7	45.7
1.5	25.3	25.3	26.7	26.7	28.0	28.0	29.4	29.4	31.2	31.2
2.5	15.2	15.2	16.0	16.0	16.8	16.8	17.6	17.6	18.7	18.7
4	9.42	9.42	9.92	9.92	10.4	10.4	10.9	10.9	11.6	11.6
6	6.28	6.28	6.62	6.62	6.96	6.96	7.29	7.29	7.74	7.74
10	3.64	3.64	3.84	3.84	4.03	4.03	4.22	4.22	4.48	4.48
16	2.31	2.31	2.43	2.43	2.56	2.56	2.68	2.68	2.85	2.85
25	1.50	1.50	1.58	1.58	1.66	1.66	1.74	1.74	1.84	1.84
35	1.07	1.07	1.13	1.13	1.18	1.18	1.24	1.24	1.31	1.31
50	0.760	0.760	0.798	0.798	0.837	0.837	0.875	0.875	0.926	0.926
70	0.551	0.551	0.577	0.577	0.603	0.603	0.630	0.630	0.665	0.665
95	0.434	0.434	0.453	0.453	0.473	0.473	0.492	0.492	0.518	0.518
120	0.356	0.356	0.370	0.370	0.385	0.385	0.399	0.399	0.419	0.419
150	0.305	0.305	0.316	0.316	0.327	0.327	0.338	0.338	0.353	0.353
185	0.270	0.270	0.279	0.278	0.287	0.287	0.295	0.295	0.307	0.307
240	0.234	0.230	0.240	0.236	0.245	0.243	0.251	0.249	0.259	0.258
300	0.215	0.206	0.219	0.211	0.223	0.216	0.227	0.221	0.232	0.228
400	0.197	0.182	0.199	0.186	0.202	0.190	0.204	0.193	0.208	0.198
500	0.187	0.167	0.188	0.170	0.190	0.173	0.192	0.176	0.194	0.179
630	0.178	0.153	0.179	0.155	0.180	0.157	0.181	0.159	0.182	0.162

NOTES:

1 These V_c values apply to a balanced three-phase circuit in which no current flows in the neutral conductor. To determine the single phase V_c the current in the neutral conductor needs to be considered by multiplying the three-phase value by $\frac{2}{\sqrt{3}} = 1.155$.

2 These V_c values should only be applied for single-core cables installed strictly in touching formation. Where single-core cables are spaced apart, e.g. in separate wiring enclosures, the V_c shall be calculated using the impedance of the cable, see Clause 4.3, and using the revised value of reactance as detailed in footnote to Tables 30 and 31.

(These V_c values may be used for cable sizes less than 25 mm² that are spaced up to 5D apart as the impact on V_c is less than 2.5% and can be ignored.)

TABLE 48

THREE-PHASE VOLTAGE DROP (V_c) AT 50 Hz

CABLE TYPES: MULTICORE FLEXIBLE CORDS AND FLEXIBLE CABLES

1	2	3	4	5	6	7	8	9	10	11
Conductor size	Three-phase voltage drop (V_c) at 50 Hz, mV/A.m									
	Conductor temperature, °C									
	45		60		75		90		110	
mm²	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.
0.5	74.2	74.2	78.2	78.2	82.2	82.2	86.1	86.1	91.4	91.4
0.75	49.5	49.5	52.1	52.1	54.8	54.8	57.4	57.4	61.0	61.0
1	37.1	37.1	39.1	39.1	41.1	41.1	43.1	43.1	45.7	45.7
1.5	25.3	25.3	26.7	26.7	28.0	28.0	29.4	29.4	31.2	31.2
2.5	15.2	15.2	16.0	16.0	16.8	16.8	17.6	17.6	18.7	18.7
4	9.42	9.42	9.92	9.92	10.4	10.4	10.9	10.9	11.6	11.6
6	6.28	6.28	6.62	6.62	6.95	6.95	7.29	7.29	7.74	7.74
10	3.64	3.64	3.83	3.83	4.03	4.03	4.22	4.22	4.48	4.48
16	2.31	2.31	2.43	2.43	2.55	2.55	2.68	2.68	2.84	2.84
25	1.49	1.49	1.57	1.57	1.65	1.65	1.73	1.73	1.84	1.84
35	1.06	1.06	1.12	1.12	1.18	1.18	1.23	1.23	1.31	1.31
50	0.749	0.749	0.788	0.788	0.827	0.827	0.866	0.866	0.917	0.917
70	0.537	0.537	0.564	0.564	0.591	0.591	0.618	0.618	0.654	0.654
95	0.418	0.418	0.437	0.437	0.457	0.457	0.477	0.477	0.504	0.504
120	0.337	0.337	0.352	0.352	0.367	0.367	0.383	0.383	0.403	0.403
150	0.283	0.283	0.295	0.295	0.306	0.306	0.318	0.318	0.334	0.334
185	0.246	0.246	0.255	0.255	0.264	0.264	0.273	0.273	0.286	0.286
240	0.207	0.206	0.213	0.213	0.219	0.219	0.225	0.225	0.234	0.234
300	0.185	0.183	0.189	0.188	0.194	0.193	0.198	0.198	0.205	0.204
400	0.165	0.160	0.168	0.164	0.171	0.167	0.174	0.171	0.178	0.176
500	0.154	0.145	0.156	0.148	0.158	0.151	0.160	0.154	0.163	0.158

NOTE: These V_c values apply to a balanced three-phase circuit in which no current flows in the neutral conductor. To determine the single phase V_c the current in the neutral conductor needs to be considered by multiplying the three-phase value by $\frac{2}{\sqrt{3}} = 1.155$.

TABLE 49

THREE-PHASE VOLTAGE DROP (V_c) AT 50 Hz

CABLE TYPES: **SINGLE-CORE AND MULTICORE MIMS, LAID IN TREFOIL**

1	2	3	4	5	6	7	8	9	10	11	12	13
Conductor size	Three-phase voltage drop (V_c) at 50 Hz, mV/A.m											
	Conductor temperature, °C											
	45		60		75		90		100		105	
mm²	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.
0.6/0.6 kV Cables												
1	32.8	32.8	34.6	34.6	36.3	36.3	38.1	38.1	39.1	31.4	39.7	31.9
1.5	21.9	21.9	23.0	23.0	24.2	24.2	25.4	25.4	26.3	21.2	26.7	21.5
2.5	13.1	13.1	13.8	13.8	14.5	14.5	15.2	15.2	15.8	12.7	16.0	12.9
4	8.20	8.20	8.64	8.64	9.08	9.08	9.52	9.52	9.87	8.00	10.01	8.11
1/1 kV Cables												
1.5	21.9	21.9	23.0	23.0	24.2	24.2	25.4	25.4	26.3	21.2	26.7	21.5
2.5	13.1	13.1	13.8	13.8	14.5	14.5	15.2	15.2	15.8	12.8	16.0	12.9
4	8.20	8.20	8.64	8.64	9.08	9.08	9.52	9.52	9.87	8.02	10.01	8.13
6	5.46	5.46	5.77	5.77	6.05	6.05	6.34	6.34	6.57	5.37	6.65	5.44
10	3.30	3.30	3.47	3.47	3.65	3.65	3.83	3.83	3.92	3.24	3.99	3.30
16	2.06	2.06	2.17	2.17	2.28	2.28	2.39	2.39	2.47	2.07	2.50	2.10
25	1.32	1.32	1.39	1.39	1.46	1.46	1.53	1.53	1.58	1.35	1.60	1.37
35	0.949	0.949	0.999	0.999	1.05	1.05	1.10	1.10	1.13	0.99	1.15	1.00
50	0.672	0.672	0.706	0.706	0.741	0.741	0.775	0.775	0.800	0.718	0.810	0.726
70	0.491	0.491	0.515	0.515	0.539	0.539	0.563	0.563	0.581	0.536	0.588	0.542
95	0.375	0.375	0.393	0.393	0.410	0.410	0.427	0.427	0.438	0.416	0.443	0.420
120	0.307	0.307	0.320	0.320	0.333	0.333	0.346	0.346	0.356	0.345	0.361	0.349
150	0.260	0.260	0.270	0.270	0.280	0.280	0.290	0.290	0.297	0.292	0.300	0.295
185	0.228	0.228	0.236	0.236	0.243	0.243	0.251	0.251	0.256	0.255	0.258	0.257
240	0.195	0.194	0.201	0.200	0.206	0.206	0.211	0.211	0.215	0.215	0.217	0.217
300	0.178	0.173	0.181	0.178	0.185	0.182	0.189	0.187	0.192	0.190	0.194	0.192
400	0.163	0.154	0.166	0.157	0.168	0.161	0.170	0.164	0.172	0.166	0.173	0.168

NOTE: These V_c values apply to a balanced three-phase circuit in which no current flows in the neutral conductor. To determine the single phase V_c the current in the neutral conductor needs to be considered by multiplying the three-phase value by $\frac{2}{\sqrt{3}} = 1.155$.

TABLE 50

THREE-PHASE VOLTAGE DROP (V_c) AT 50 Hz

CABLE TYPE: AERIAL WITH BARE OR INSULATED COPPER CONDUCTORS

1	2	3	4	5	6	7
Conductor size (mm²) or stranding (No./mm)	Three-phase voltage drop (V_c) at 50 Hz, mV/A.m					
	Conductor temperature, °C					
	45		60		75	
	Max	0.8 p.f	Max	0.8 p.f	Max	0.8 p.f
7/1.00	6.22	6.22	6.55	6.55	6.88	6.88
6	6.06	6.06	6.39	6.39	6.71	6.71
7/1.25	4.02	4.02	4.23	4.23	4.45	4.45
10	3.63	3.63	3.82	3.82	4.01	4.01
16	2.32	2.32	2.44	2.44	2.55	2.55
7/1.75	2.10	2.10	2.20	2.20	2.31	2.31
7/2.00	1.65	1.65	1.73	1.73	1.81	1.81
25	1.53	1.53	1.60	1.60	1.67	1.67
35	1.16	1.16	1.21	1.21	1.26	1.26
7/2.75	0.981	0.981	1.02	1.02	1.06	1.06
50	0.920	0.920	0.954	0.954	0.988	0.988
19/1.75	0.915	0.915	0.948	0.948	0.982	0.982
19/2.00	0.768	0.765	0.791	0.790	0.815	0.815
70	0.725	0.720	0.745	0.742	0.767	0.765
7/3.50	0.719	0.712	0.738	0.734	0.758	0.756
7/3.75	0.667	0.654	0.683	0.673	0.700	0.692
95	0.620	0.601	0.633	0.618	0.647	0.635
37/1.75	0.619	0.599	0.632	0.616	0.646	0.632
19/2.75	0.562	0.527	0.571	0.540	0.580	0.553
120	0.556	0.521	0.565	0.534	0.574	0.547
19/3.00	0.529	0.482	0.535	0.493	0.542	0.504
150	0.517	0.469	0.523	0.479	0.530	0.490
185	0.485	0.422	0.489	0.431	0.493	0.439
37/2.50	0.484	0.419	0.488	0.427	0.492	0.435

NOTES:

1 These V_c values apply to a balanced three-phase circuit in which no current flows in the neutral conductor. To determine the single phase V_c the current in the neutral conductor needs to be considered by multiplying the three-phase value by $\frac{2}{\sqrt{3}} = 1.155$.

2 These V_c values are based on a spacing of 0.4 m.

3 For aerial bundled cables (ABC), use XLPE single-core, trefoil figures.

TABLE 51

THREE-PHASE VOLTAGE DROP (V_c) AT 50 Hz

CABLE TYPE: AERIAL WITH BARE OR INSULATED ALUMINIUM CONDUCTORS

1	2	3	4	5	6	7
Conductor size (mm²) or stranding (No./mm)	Three-phase voltage drop (V_c) at 50 Hz, mV/A.m					
	Conductor temperature, °C					
	45		60		75	
	Max.	0.8 p.f.	Max.	0.8 p.f.	Max.	0.8 p.f.
16	3.68	3.68	3.87	3.87	4.07	4.07
25	2.35	2.35	2.47	2.47	2.59	2.59
35	1.74	1.74	1.82	1.82	1.91	1.91
7/2.50	1.68	1.68	1.76	1.76	1.84	1.84
7/2.75	1.41	1.41	1.48	1.48	1.55	1.55
50	1.33	1.33	1.39	1.39	1.45	1.45
7/3.00	1.22	1.22	1.27	1.27	1.33	1.33
70	0.980	0.980	1.02	1.02	1.06	1.06
7/3.75	0.863	0.863	0.894	0.894	0.925	0.925
95	0.776	0.776	0.802	0.802	0.829	0.829
7/4.50	0.686	0.680	0.705	0.701	0.725	0.722
120	0.671	0.666	0.690	0.686	0.709	0.707
7/4.75	0.647	0.637	0.664	0.656	0.680	0.675
150	0.601	0.587	0.615	0.604	0.630	0.621
19/3.25	0.572	0.551	0.584	0.566	0.596	0.581
185	0.543	0.516	0.552	0.530	0.563	0.543
19/3.50	0.537	0.507	0.546	0.520	0.555	0.533

NOTES:

1 These V_c values apply to a balanced three-phase circuit in which no current flows in the neutral conductor. To determine the single phase V_c the current in the neutral conductor needs to be considered by multiplying the three-phase value by $\frac{2}{\sqrt{3}} = 1.155$.

2 These V_c values are based on a spacing of 0.4 m.

3 For aerial bundled cables (ABC), use XLPE single-core, trefoil figures.

SECTION 5 SHORT-CIRCUIT PERFORMANCE

5.1 GENERAL

This Section is applicable to the short-circuit maximum temperature rating of electric cables having a rated voltage not exceeding 0.6/1 kV. Guidance is given on the following aspects:

(a) Maximum permissible short-circuit temperatures for cable—

  (i) insulating materials;

  (ii) outer jacket and bedding materials; and

  (iii) conductor and metallic sheath materials and components.

(b) The influence of the method of installation on the temperature limit.

(c) The calculation of the permissible short-circuit current in the current-carrying components of the cable.

5.2 FACTORS GOVERNING THE APPLICATION OF THE TEMPERATURE LIMITS

The short-circuit temperatures given in Clause 5.5 are the actual temperatures of the current-carrying component as limited by the adjacent materials in the cable and are valid for short-circuit durations of up to 5 s. These temperatures will only be obtained in practice if non-adiabatic heating is assumed (that is, an appropriate allowance for heat loss into the dielectric during the short-circuit is made) when calculating the allowable short-circuit current for a given time (not longer than 5 s). The use of the adiabatic method (that is, when heat loss from the current-carrying component during the short-circuit is neglected) gives short-circuit currents that are on the safe side. The 5-second period quoted is the limit for the temperatures quoted to be valid, not for the application of the adiabatic calculation method. The time limit for the use of the adiabatic method has a different definition, being a function of both the short-circuit duration and the cross-sectional area of the current-carrying component.

For thermoplastic insulating materials the limits should be applied with caution when the cables are either directly buried or securely clamped when in air. Local pressure due to clamping or the use of an installation radius less than 8 times the cable outside diameter, especially for cables that are rigidly restrained, can lead to high deforming forces under short-circuit conditions. Where these conditions cannot be avoided it is suggested that the limit be reduced by 10°C. The limits quoted are based on average hardness grades of PVC and some adjustment may be necessary for other grades, especially those compounded for improved low-temperature properties.

NOTES:

1 Caution should be exercised when using the limits recommended for thermosetting materials on large conductors because the high mechanical forces combined with any residual characteristics could result in deformation sufficient to cause failure.

2 Caution may be needed with total cross-sectional areas in the region of 1000 mm^2 when using the conductor temperatures specified for impregnated paper, cross-linked polyethylene (XLPE) and ethylene propylene rubber (EPR) insulation and the cable is sheathed with a lower-temperature material.

3 Information on the short-circuit performance of MIMS cable is not included in this Standard and reference should be made to manufacturer's recommendations.

5.3 CALCULATION OF PERMISSIBLE SHORT-CIRCUIT CURRENTS

The following adiabatic method, which neglects heat loss, is accurate enough for calculating permissible conductor and metallic sheath short-circuit currents for the majority of practical cases and any error is on the safe side. However, for thin screens the adiabatic method indicates much higher temperature rises than actually occur in practice and thus should be used with some discretion.

The generalized form of the adiabatic temperature rise equation, which is applicable to any starting temperature, is as follows:

$$I^2 t = K^2 S^2 \qquad \ldots 5.3$$

where

I = short-circuit current (r.m.s. over duration), in amperes

t = duration of short circuit, in seconds

K = constant depending on the material of the current-carrying component, the initial temperature and the final temperature

NOTE: See Table 52 for values of constant (K).

S = cross-sectional area of the current-carrying component, in square millimetres.

NOTES:

1 For conductors and metallic sheaths, it is sufficient to take the nominal cross-sectional area but in the case of screens, this quantity requires careful consideration.

2 An example of the application of this method is provided in Appendix A, Paragraph A8.

TABLE 52

VALUES OF CONSTANT K FOR DETERMINATION OF PERMISSIBLE SHORT-CIRCUIT CURRENTS

Initial temperature of conductor °C	Constant (*K*)													
	Final temperature of conductor, °C													
	Copper						Aluminium				Lead		Steel	
	140	150	160	220	250	350	140	150	160	250	150	200	150	200
130	37.2	52.2	63.6	106	121	155	24.6	34.5	42.0	79.6	9.5	17.3	18.9	34.1
125	45.7	58.6	68.9	109	123	158	30.2	38.7	45.5	81.5	10.7	17.9	21.2	35.4
110	65.3	74.9	83.2	119	132	164	43.2	49.5	55.0	87.1	13.7	19.9	27.1	39.3
90	85.6	93.1	99.9	131	143	173	56.6	61.5	66.0	94.5	17.0	22.3	33.7	44.1
85	90.1	97.3	104	134	146	176	59.5	64.3	68.6	96.3	17.8	22.9	35.2	45.3
80	94.4	101	108	137	149	178	62.4	67.0	71.1	98.1	18.5	23.5	36.7	46.4
75	98.7	105	111	140	151	180	65.2	69.6	73.6	99.9	19.2	24.0	38.2	47.6
70	103	109	115	143	154	182	68.0	72.2	76.0	102	19.9	24.6	39.6	48.8
65	107	113	119	146	157	185	70.7	74.7	78.4	104	20.6	25.2	41.0	49.9
60	111	117	122	149	159	187	73.3	77.2	80.8	105	21.3	25.7	42.4	51.0
55	115	120	126	152	162	189	75.8	79.6	83.1	107	22.0	26.3	43.7	52.2
50	118	124	129	155	165	192	78.4	82.0	85.5	109	22.7	26.9	45.1	53.3
45	122	128	133	158	168	194	80.9	84.4	87.7	111	23.3	27.4	46.4	54.4
40	126	131	136	160	170	196	83.3	86.8	90.0	113	24.0	28.0	47.7	55.6
35	130	135	140	163	173	199	85.8	89.1	92.3	114	24.6	28.5	49.1	56.7
30	133	138	143	166	176	201	88.2	91.5	94.5	116	25.3	29.1	50.4	57.8
25	137	142	146	169	179	204	90.6	93.8	96.8	118	25.9	29.6	51.7	59.0

5.4 INFLUENCE OF METHOD OF INSTALLATION

When it is intended to make full use of the short-circuit limits of a cable, consideration should be given to the influence of the method of installation. An important aspect concerns the extent and nature of the mechanical restraint imposed on the cable. Longitudinal expansion of a cable during a short-circuit can be significant and when this expansion is restrained the resultant forces are considerable.

Where cables are installed in air, provision should be made so that expansion may be absorbed uniformly along the length by snaking rather than permitting it to be relieved by excessive movement at a few points only. Fixings should be spaced sufficiently far apart to permit lateral movement of multicore cables or groups of single-core cables.

Where cables are buried directly in the ground, or are restrained by frequent fixing, provision should be made to accommodate the resulting longitudinal forces on terminations and joint boxes. Sharp bends should be avoided because the longitudinal forces are translated into radial pressures at bends in the cable route and these may damage thermoplastic components of the cable such as insulation and sheaths. Attention is drawn to the minimum bending radius recommended for the type of cable. For cables in air, it is also desirable to avoid fixings at a bend, which may cause local pressure on the cable.

In determining the short-circuit stresses that will be imposed on a cable, the characteristics of the protective devices used shall be considered.

5.5 MAXIMUM PERMISSIBLE SHORT-CIRCUIT TEMPERATURES

5.5.1 General

Taking into account the recommendation given in Clause 5.2, the temperature values given in Tables 52 to 54 are—

(a) the actual temperatures of the current-carrying components; and

(b) the limits specified for short-circuits of up to 5 s duration.

5.5.2 Insulating materials

The temperature limits given in Table 53 are for all types of conditions when the insulating materials specified are in contact with conductors.

TABLE 53

TEMPERATURE LIMITS FOR INSULATING MATERIALS IN CONTACT WITH CONDUCTORS

Material	Temperature limit °C
Thermoplastic: LLDPE, PE, V-75, HFI-75-TP, TPE-75, V-90, HFI-90-TP, TP 90 and V-90HT	
—up to and including 300 mm^2	160
—greater than 300 mm^2	140
Cross-linked elastomeric: R-EP-90, R-CPE-90, R-HF-90,	
R-CSP-90, R-HF-110, and R-E-110	250
Cross-linked polyolefin: X-90, X-90UV, X-HF-90 and X-HF-110	250
High temperature: R-S-150 and Type 150 fibrous	350

5.5.3 Outer sheath and bedding materials

The temperature limits given in Table 54 are for the outer sheath and bedding materials comprising a continuous screen/sheath or a complete layer of armour wires. These temperatures are for materials where there are no electrical or other requirements necessary, i.e. screen/sheath/armour temperature limits when in contact with the outer sheath materials but thermally separated from the insulation by layers of suitable material of sufficient thickness. If thermal separation is not provided, the temperature limits of the insulation should be used if it is lower than that of the sheath.

TABLE 54

TEMPERATURE LIMITS FOR OUTER SHEATH AND BEDDING MATERIALS

Material	Temperature limit °C
Thermoplastic	200
Polyethylene	150
High density polyetheylene	180
Polychloroprene, chlorosuphonated polyethylene and similar	200

5.5.4 Conductor and metallic sheath materials and components

The temperature limits specified in Table 55 apply to the conductor and metallic sheath materials and components.

NOTE: Limitations of materials in contact with these metals should also be considered.

TABLE 55

TEMPERATURE LIMITS FOR CONDUCTOR AND METALLIC SHEATH MATERIALS AND COMPONENTS

Metals	Condition	Temperature limit °C
Copper and aluminium	Conductor only*	†
	Welded joint	†
	Exothermic welded joint	250‡
	Soldered joint	160
	Compression (mechanical deformation) joint	250‡
	Mechanical (bolted) joint	§
Lead		170
Lead alloy		200
Steel		†

* Includes concentric neutral conductors.
† Limited by the material with which it is in contact.
‡ Temperature of adjacent conductor, actual joint will be at a lower temperature.
§ Refer to manufacturer's recommendations.

APPENDIX A

EXAMPLES OF THE SELECTION OF CABLES TO SATISFY CURRENT-CARRYING CAPACITY, VOLTAGE DROP AND SHORT-CIRCUIT PERFORMANCE REQUIREMENTS

(Informative)

A1 EXAMPLE 1

A1.1 Problem

An underground 1600 A three-phase circuit is to be made up of parallel circuits of 400 mm^2 V-75 single-core insulated and sheathed copper cables. Determine the minimum number of active conductors required for each of the following forms of installation:

(a) All cables in one conduit or duct.

(b) Each parallel circuit comprising three cables in one conduit or duct.

(c) Each parallel circuit comprising a trefoil group of single-way underground ducts.

(d) Each parallel circuit comprising a trefoil group of three cables buried direct.

A1.2 Solution

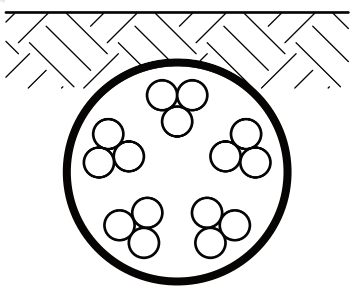
Assuming that the conditions specified in Clause 3.4 apply, i.e. soil ambient temperature, thermal resistivity and depth of laying, the following methods would satisfy the load requirements, if the voltage drop is acceptable:

(a) *Method A—Single conduit or duct* Current-carrying capacity of single 400 mm^2 circuit = 541 A (Table 7, Column 24).

From the derating factors of Table 22, which vary according to the number of enclosed circuits, it can be shown that five parallel circuits of 400 mm^2 conductors, as illustrated, are required.

The current-carrying capacity of the arrangement is—

$541 \times 5 \times 0.6 = 1623$ A.

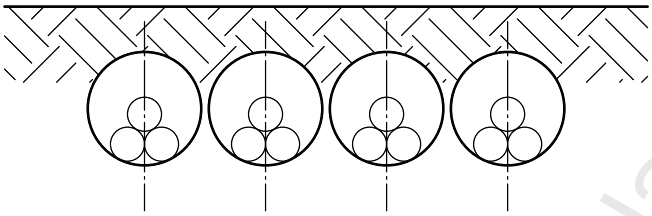


(b) *Method B—Groups of conduits or ducts* Current-carrying capacity of single 400 mm^2 circuit = 541 A (Table 7, Column 24).

From the derating factors of Table 26(2) for groups of underground enclosures, it can be shown that four conduits or ducts, each containing a circuit of 400 mm^2 conductors and touching, as illustrated, are required.

The current-carrying capacity of the arrangement is—

541 × 4 × 0.79 = 1709.6 A.

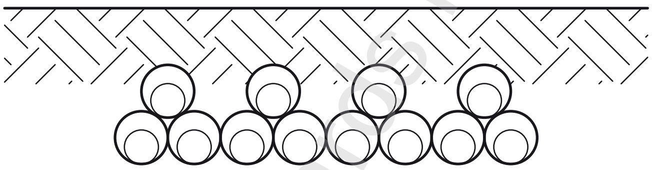


(c) *Method C—Trefoil groups of single-way underground ducts* Current-carrying capacity of single 400 mm^2 circuit = 608 A (Table 7, Column 27).

From the derating factors of Table 26(1) for groups of underground enclosures, it can be shown that four trefoil groups of single-way underground ducts, each group representing a circuit of 400 mm^2 conductors, as illustrated, are required.

The current-carrying capacity of the arrangement—

608 × 4 × 0.74 = 1800 A.

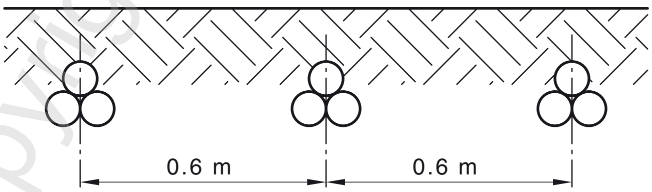


(d) *Method D—Trefoil groups of cable buried direct* Current-carrying capacity of single 400 mm^2 circuit = 652 A (Table 7, Column 22).

From the derating factors of Table 25(1) for groups of single-core cables buried direct, it can be shown that three trefoil groups of single-core cables, each group representing a circuit of 400 mm^2 conductors and spaced apart, as illustrated, are required.

The current-carrying capacity of the arrangement is—

652 × 3 × 0.87 = 1701.7 A.



A1.3 Comparison of different methods

Each of the four methods of installation described in Paragraph A1.2 provide a satisfactory solution to the circuit design problem where the number of 400 mm^2 active conductors are to be kept to a minimum for a given installation method. However, in doing so the following factors that may determine the system to be selected are highlighted:

(a) *Number of cables* Method A leads to the largest number of cables.

(b) *Number of enclosures* Method C requires twelve enclosures (excluding neutral) whilst Method D requires none.

(c) *Size of enclosures* The enclosures in Method C need only be sufficient to accommodate one conductor. However, the single enclosure in Method A will need to be considerably larger.

(d) *Size of excavated trench* Methods A, B and C require relatively small trench widths in comparison to Method D.

(e) *Provision for additional load* Methods B, C and D have provision for a further load increase of approximately 100 A to 200 A. Method A would be operating at near maximum load.

The relative importance of these different factors for a particular installation will, in general, determine the cable arrangement selected.

A2 EXAMPLE 2

A2.1 Problem

If 12 loaded single-core conductors are run through a wiring enclosure what derating factor should be applied?

A2.2 Solution

The applicable derating factors could be determined from Table 22. If it is a three-phase circuit, then 12/3 is 4 groups, i.e. 4 circuits, and a derating factor of 0.65 could be applied. If the circuits are single-phase, there would be 6 circuits and therefore a derating factor of 0.57 could be applied.

Applying these derating factors for, say, V-75 insulated 4 mm^2 conductors, from Table 7 a three-phase current-carrying capacity is 32 A while the single-phase value from Table 4 is 36 A.

Using the three-phase approach, $32 \times 0.65 = 20.8$ A.

Using the single-phase approach, $36 \times 0.57 = 20.5$ A.

Note that these methods result in approximately the same answer.

A3 EXAMPLE 3

A3.1 Problem

A three-phase circuit is to supply a load of 125 A per phase. It is proposed to use two V-75 insulated and sheathed four-core cables bunched together on a surface in a confined ceiling space where the ambient air temperature is 50°C.

Determine—

(a) the minimum conductor size; and

(b) the maximum route length of the circuit if a voltage drop of 3% is permitted on the circuit,

for both aluminium and copper conductors.

A3.2 Solution

The solution is as follows:

(a) Minimum cable size:

Derating factor for bunching = 0.8 (Table 22, Column 5)

Derating factor for 50°C ambient = 0.72 (Table 27(1), Column 9)

Minimum current-carrying capacity of two parallel cables—

$$125 \times \frac{1}{0.8} \times \frac{1}{0.72} = 217\ \text{A}$$

or 108.5 A per cable.

From Columns 5, 6 and 7 of Table 13, the minimum size of the two cables making up the circuit are—

Aluminium—50 mm^2

Copper—35 mm^2

(b) Maximum route length:

With the same length and disposition of the two cables throughout the circuit, balanced current flow between the parallel cables can be expected.

Assuming worst case conditions of cable operating temperature and load power factor, the simplified method of Clause 4.2 may be used to determine the maximum route length of the circuit (L), in metres, by substitution of the 62.5 A load current for each cable and 3% (12.0 V) permissible voltage drop in the following equation:

$$L = \frac{1000 \times V_d}{I \times V_c} \quad \text{. . . A3.2}$$

The values of V_c are obtained from Table 42 for copper and Table 45 for aluminium and result in the following maximum route lengths:

Aluminium $\frac{1000 \times 12.0}{62.5 \times 1.36} = 141.2\ \text{m}$

Copper $\frac{1000 \times 12.0}{62.5 \times 1.11} = 173.0\ \text{m}$

A4 EXAMPLE 4

A4.1 Problem

Six four-core V-75 insulated and sheathed copper cables are arranged touching in a single horizontal row on a perforated cable tray for the supply of six identical 22 kW motors which have a full-load current of 45 A per phase and are installed at distances of 40 m, 55 m, 90 m, 135 m, 180 m and 225 m from the origin of the cable tray. Determine the minimum conductor size if a voltage drop of 2.3% (10 V) is permitted for each cable.

A4.2 Solution

The selection of conductor size in this instance should satisfy both the current-carrying capacity requirement, including the effect of the cables being grouped, and the voltage drop limitation.

The cable sizes required to satisfy the voltage drop restriction are assessed using the formula of Clause 4.2, the actual load current of 45 A, the permissible voltage drop, V_d, of 10 V and the three-phase voltage drop Figures of Table 42. The results of these calculations, the current-carrying capacity given in Table 13 and its ratio to the load current, are as follows:

Cable	Length	Maximum V_c	Minimum cable size	Maximum current-carrying capacity	Ratio of actual load current to max. current-carrying capacity of cable
	m	mV/A.m	mm^2	A	
A	40	5.56	10	58	0.78
B	55	4.04	10	58	0.78
C	90	2.47	16	78	0.58
D	135	1.65	25	104	0.43
E	180	1.23	35	128	0.35
F	225	0.98	50	156	0.29

Because of voltage drop limitations, Cables C to F are substantially larger than required to meet the maximum current-carrying capacity requirements. As a result the contribution of these cables to the effects of mutual heating will be small, in the case of Cables D, E and F, almost negligible.

An examination of the derating factors for groups of multicore cables on perforated trays given in Table 24 would indicate that a factor of 0.76 (Column 9) would apply if all six cables in the group were loaded to achieve the same conductor temperature. Although these conditions do not exist for all cables in this example, the application of this factor will give a conservative but practical solution, as follows:

$$\text{Minimum current-carrying capacity required of cables} = 45\times\frac{1}{0.76}=59.2A$$

Minimum cable size = 16 mm^2 (Table 13, Column 5)

As expected, only Cables A and B are affected and therefore the recommended minimum cable sizes for the Cables A, B, C, D, E and F will be 16 mm^2, 16 mm^2, 16 mm^2, 25 mm^2, 35 mm^2 and 50 mm^2 respectively.

NOTE: The actual derating factor in this situation may be closer to 0.82, the derating factor for three cables on a tray, which allows for restricted ventilation to cables nested in the middle of others. Alternative arrangements of the cables, e.g. spacing Cables A and B, which operate at a higher temperature, away from each other and others in the group, may also give rise to less onerous derating factors and smaller cable sizes.

A5 EXAMPLE 5

A5.1 Problem

Five single-phase circuits of two-core flat V-75 insulated and sheathed cables are fixed to a wall. Where the continuous loading of the cables is assessed as 16, 20, 25, 32, and 40 A, determine the minimum cable sizes required where the cables are in one of the following conditions:

(a) Condition A—spaced apart in a single layer in accordance with Clause 3.5.2.2(c) and Figure 1.

(b) Condition B—spaced apart in a single layer by a distance of one cable diameter between adjacent cables.

(c) Condition C—touching in a single layer.

(d) Condition D—bunched together.

A5.2 Solution

The solution is as follows:

(a) For installation condition A to avoid derating because of grouping, Clause 3.5.2.2(c) and Figure 1 require a minimum vertical spacing between adjacent cables 6 times the diameter of the largest cable in the group.

(b) For Condition B, the derating factor = 0.90 (Table 22, Column 8).

(c) For Condition C, the derating factor = 0.73 (Table 22, Column 8).

(d) For Condition D, the derating factor = 0.60 (Table 22, Column 8).

The minimum conductor sizes determined from Column 5 of Table 10 are as follows:

Load	Cable size, mm^2			
A	Spaced 6 diameters	Spaced 1 diameter	Touching single layer	Bunched
16	1.0	1.5	1.5	2.5
20	1.5	2.5	2.5	4
25	2.5	2.5	4	4
32	4	4	6	10
40	4	6	10	10

A6 EXAMPLE 6

A6.1 Problem

A single-phase circuit comprises two 16 mm^2 copper single-core sheathed cables with V-75 insulation installed unenclosed on a wall for the supply of a 55 A resistive load.

Determine which single-phase voltage drop values will apply when the cable is operating in—

(a) an ambient air temperature of 30°C; or

(b) an ambient air temperature of 15°C

A6.2 Solution

From Table 4 it will be noted that the cable current-carrying capacity of this configuration is 72 A in an ambient air temperature of 30°C. Equation 4.4(1) may therefore be solved directly for cable operating temperature (θ_0) where the ambient air temperature is 30°C but requires some correction to the rated current (I_R) before application to an ambient air temperature of 15°C. Appropriate calculations are as follows:

(a) *Ambient air temperature 30°C*

$$\left(\frac{55}{72}\right)^2 = \frac{\theta_0 - 30}{75 - 30} \qquad \text{. . . A6.2(1)}$$

θ_0 = 56.25°C, rounding to 56°C for calculation purposes

The three-phase voltage drop for this cable configuration and operating temperature obtained from Table 41 is 2.32 mV/A.m. The single-phase value is then determined in accordance with Clause 4.3.3(a)—

single-phase voltage drop value = 1.155 × 2.32

= 2.68 mV/A.m

(b) *Ambient air temperature 15°C* The correction factor for operation in a 15°C ambient air temperature is used to determine the maximum current that will give rise to the maximum operating temperature of 75°C.

Correction factor = 1.18 [from Table 27(1)]

$$\left(\frac{55}{72\times 1.18}\right)^2 = \frac{\theta_0 - 15}{75-15} \quad \text{. . . A6.2(2)}$$

θ_0 = 40.14°C, rounding to 40°C for calculation purposes

The three-phase voltage drop for this cable configuration and operating temperature obtained from Table 41 is 2.20 mV/A.m. The single-phase value is then determined in accordance with Clause 4.3.3(a)—

single-phase voltage drop value = 1.155 × 2.20

= 2.54 mV/A.m

A7 EXAMPLE 7

A7.1 Problem

A three-phase circuit comprises 3 × 150 mm^2 single-core copper V-75 sheathed active conductors and a 1 × 70 mm^2 single-core copper V-75 sheathed neutral conductor bunched together in free air at an ambient air temperature of 30°C. Given the same length of 150 m for all conductors, determine the maximum voltage drop when the magnitude and phase angle of the currents in the respective active conductors are as follows:

$$I_A = 195\ \angle 0°\ \text{A}$$

$$I_B = 300\ \angle 120°\ \text{A}$$

$$I_C = 230\ \angle 240°\ \text{A}$$

A7.2 Solution

It is not necessary in this example to take into account the load power factor as the maximum voltage drop conditions are assumed where load power factor and cable power factor are equal. The voltage drop in each cable will then be equal to ILZ_c.

The 300 A load current in Phase B is, according to Table 7, close to the maximum permissible for such an arrangement and consequently the conductor operating temperature may be assessed as 75°C for the application of Table 40 corresponding to a three-phase voltage drop of 0.305 mV/A.m.

The voltage drop on Phase B conductor alone is therefore—

$$\begin{aligned} V_{dB} &= I_B L_B Z_{cB} \\ &= 300\ \angle 120° V \times 150 \times \frac{0.305}{\sqrt{3}} \times \frac{1}{1000} \\ &= 7.924\ \angle 120° V \end{aligned} \quad \text{. . . A7.2(1)}$$

The current flowing in the neutral is determined from the relationship—

$$\begin{aligned} I_A + I_B + I_C + I_N &= 0 \\ &= 195\ \angle 0° + 300\ \angle 120° + 230\ \angle 240° \\ &= 195 + (-150 + j259.8) + (-115 - j199.2)\ \text{A} \\ &= -70 + j60.6 \end{aligned} \quad \text{. . . A7.2(2)}$$

$$\therefore I_{N} = 70 - j60.6$$
$$= 92.6 \angle -40.9°A$$

The operating temperature of the neutral may then be determined in accordance with Clause 4.4 and the rated figure given in Table 7, i.e.—

$$\left(\frac{92.6}{210}\right)^2 = \frac{\theta_0 - 30}{75 - 30} \qquad \text{. . . A7.2(3)}$$

where

θ_0 = 38.75°C, say 45°C allowing for contact with conductors operating at higher temperatures.

From Table 40 and a conductor temperature of 45°C the three-phase voltage drop is given as 0.537 mV/A.m.

The voltage drop on the neutral conductor alone is therefore—

$$V_{dN} = I_N L_N Z_{cN}$$
$$= 92.6 \angle -40.9°V \times 150 \times \frac{0.537}{\sqrt{3}} \times \frac{1}{1000} \qquad \text{. . . A7.2(4)}$$
$$= 4.306 \angle -40.9°V$$

The maximum single-phase voltage drop is therefore—

$$V_d = V_{dB} - V_{dN} = 7.924 \angle 120° - 4.306 \angle -40.9°$$
$$= -3.962 + j6.862 - 3.255 + j2.819$$
$$= -7.217 + j9.681 \qquad \text{. . . A7.2(5)}$$
$$= 12.08 \angle 126.7° \text{ V}$$

A8 EXAMPLE 8

A8.1 Problem

Select the minimum size conductor based on thermal consideration, for a copper cable with compression joints connected to a supply where protection is provided by an air circuit-breaker with a clearance time of 1 s and a breaking capacity of 10 kA.

Calculate the minimum conductor size for the following two types of cable:

(a) PVC insulated.

(b) XLPE insulated.

A8.2 Solution

The solution is as follows:

(a) *PVC insulated*

(i) To find the value of constant (K) the initial conductor temperature and the final conductor temperature should be known.

(ii) For PVC it is assumed that the initial operating temperature is 75°C (for V-75, V-90 and V-90HT). From Table 53, and assuming that the cable is smaller than 300 mm^2, the final operating temperature can be selected as 160°C. From Table 52 the value of K can be selected as 111 for a copper conductor.

(iii) As the circuit-breaker protecting the circuit is rated at 10 kA breaking capacity, we can assume a value of 10 000 A for I.

(iv) As the clearance time of the circuit-breaker is 1 s, it can be assumed that the value of t, which is the total time the fault current is flowing, is also 1 s.

(v) Rearranging Equation 5.3(1) we get—

$$S = \sqrt{\left(\frac{I^2 t}{K^2}\right)} \qquad \text{. . . A8.2(1)}$$

Substituting the values for I, t and K, the minimum cross-section area is calculated as—

$$S = \sqrt{\left[\frac{(10\,000)^2 \times 1}{(111)^2}\right]} \qquad \text{. . . A8.2(2)}$$

$$= 90.1\,\text{mm}^2$$

Therefore, the minimum cable size would be 95 mm^2.

(b) *XLPE insulation*

Using the same process as in Item (a) the following steps are taken:

(i) Initial operating temperature for X-90 insulation (assumed maximum) ..... 90°C.

Final operating temperature from X-90 insulation (from Table 53) ....250°C.

Value of constant (K) from Table 52..143.

(ii) Value of short-circuit current (I).. 10 000 A.

(iii) Value of time (t) is .... 1 s.

$$S = \sqrt{\left(\frac{I^2 t}{K^2}\right)} \qquad \text{. . . A8.2(3)}$$

$$2 = \sqrt{\left[\frac{(10\,000)^2 \times 1}{(143)^2}\right]}$$

$$= 69.9\ \text{mm}^2$$

Therefore, the minimum cable size would be 70 mm^2.

A9 EXAMPLE 9

A9.1 Economic cable sizing

The principle of economic cable sizing is to select a cable size of minimum admissible cross-sectional area that is safe to use and where the cost of the losses that will occur during the life of the cable are minimized. This objective is met by optimizing the present value of upfront costs and cost savings that are due to lifetime savings for the electricity consumer. Such cable should always be of greater cross-sectional area than one that is selected through the application of the normal safety based processes explained in Clauses 2.2 to 2.5 of this Standard and others (e.g. AS/NZS 3000).

The process of selecting a cable size that is based on economic arguments, in this example, has six main steps which are illustrated below.

Results are sensitive to input parameters such as cost of electricity, cable and installation and care should be taken to ensure that all data is appropriate for each installation.

The beneficiary, in this example, is assumed to be the entity that pays for both the upfront costs and the electricity bill for an economically sufficient period.

A9.2 Problem

Three copper conductor, XLPE insulated, single-core cables are arranged in a single horizontal row touching each other on a cable ladder for the supply of an electric motor which has a full-load current of 200 A per phase. The installation has a route length of 100 m and the ambient air temperature is 30°C.

Determine the minimum conductor size—

(a) that fulfils the current carrying requirements; and

(b) that permits a maximum voltage drop of 2.4% (10 V); and

(c) has the least lifetime cost when the motor is operated at 80% of its full-load current.

A9.3 Solution

Step 1 Basic information

Using normal practice of considering current-carrying capacity and voltage drop requirements, the initial cross-sectional area of conductor is selected. In this example, such practice selects a 95mm^2 conductor size. The cables considered for economic optimization in this example are nominal sizes with conductors ranging in cross-sectional area from 95 mm^2 to 630 mm^2, but this does not preclude the use of other cross-sectional areas including those achieved with combinations of conductors that are connected in parallel.

The utility represents the percentage of daily use and the current expressed as a fraction of the maximum demand. In this example the utility is set at full time use and 80% of the maximum demand current. Since losses are proportional to the square of current, if the current is not the maximum demand then the losses will be lower leading to a conservative value for the optimal conductor size.

The initial information is summarized in Table A9.1 below:

TABLE A9.1

SUMMARY OF INFORMATION

Maximum demand A	Conductor cross-sectional area mm^2	Maximum voltage drop V	Route length m	Utility %
200	95	10	100	80

Step 2 Calculate phase conductor operating temperature and a.c. resistance

Column 5 of Table 8 provides the current rating. For a three-phase circuit comprising 3 × 95 mm^2 single core copper conductor, XLPE insulated phase cables and 1 × 25 mm^2 single core copper conductor, XLPE insulated earth cable, the current rating is 328 A. The phase conductor temperature (θ_0) is estimated by using Equation 4.4(1). The calculated temperature is then raised to the nearest temperature 45°C, 60°C, 75°C, 80°C, 90°C or 110°C for use with Table 34 to determine the conductor a.c. resistance:

$$\left(\frac{200 \times 80\,\%}{328}\right)^2 = \frac{\theta_0 - 30}{90 - 30} \qquad \text{. . . A9.3(1)}$$

where

θ_0 = 44°C, raised to 45°C

Therefore the a.c. resistance of the 95 mm^2 is 0.213 Ω/km (Table 34, Column 2).

The a.c. resistance for a route length of 100 m = 0.213 × 0.1 = 0.0213 Ω.

Step 3 Calculate $I^2 R$ loss of the cable

At 80% utility (a current of 160 A), the I^2R loss of the cable is calculated as follows:

$$I^2R = (80\% \times 200)^2 \times 0.0213 = 545 \text{ W per phase or } 1636 \text{ W for three-phase} \quad \ldots \text{A9.3(2)}$$

where

I = current flowing in the conductor, in amperes

R = a.c. resistance of the conductor, in ohms

The a.c. resistance of the conductor is lower when the utility is 80% because the conductor temperature is lower.

In this example, the unit cost of electricity is assumed to be 15 c/kWh. The annual cost of 1636 W is therefore—

$1.636 \times 0.15 \times 24 \times 365 = \$2149$

The above steps are to be repeated for all cable sizes considered in the example.

TABLE A9.2

SUMMARY OF CALCULATIONS

1	2	3	4	5	6	7	8	9	10
Phase conductor size mm²	Earth conductor size* mm²	Upfront cost (3 phase plus earth)† $	Current rating‡ A	Phase conductor tempera-ture °C	Increase in upfront cost over cost of 95 mm cable (cc) $	a.c. resistance of phase conductor § Ω	I^2R loss of cable (3 phase kW	Cost of I^2R loss $/year	I^2R loss savings (Y) $/year
95	25	3 511	328	44	—	0.0213	1.636	2 149	—
120	35	4 416	384	40	905	0.017	1.306	1 716	433
150	50	5 490	443	38	1 979	0.0138	1.060	1 393	756
185	70	6 874	515	36	3 363	0.0111	0.852	1 120	1 029
240	95	8 996	616	34	5 485	0.00862	0.662	870	1 279
300	120	11 260	713	33	7 749	0.00703	0.540	709	1 440
400	120	13 854	832	32	10 343	0.00569	0.437	574	1 575
500	120	17 513	961	32	14 002	0.00467	0.359	471	1 678
630	120	22 278	1 076	31	18 767	0.00389	0.299	393	1 756

* Earth size in accordance with AS/NZS 3000:2007 Table 5.1.

† Indicative cost of 4 single core cables, i.e. 3 × 1C phase and 1 × 1C earth, only. Additional installation and other costs, if incurred, should be added to these numbers.

‡ Table 8, Column 5.

Table 34, Column 2 to Column 6 and adjusted for a route length of 100 m.

Step 4 Calculation of the net present value of the total cost of the installation

The NPV of the total cost is the difference between the NPV of savings in the cost of I^2R loss over the time period and the increase in upfront costs.

$$NPV_{\text{total}} = NPV_{\text{savings}} - cc \quad \text{. . . A9.3(3)}$$

where

NPV_{total} = Net present value of the total cost of the installation, in $

NPV_{savings} = Net present value of the savings in the cost of I^2R loss, in $

$$= \frac{Y\left(1-(1+r)^{-n}\right)}{r} \quad \text{. . . A9.3(4)}$$

cc = increase in capital expenditure, in $, i.e. additional cable cost and other upfront costs, as a result of using a larger cable in today's value

where

n = time period, in years = 20 years (see Note 1)

r = discount rate, in % = 7% (see Note 2)

Y = savings in cost of I^2R loss (a cash flow) as a result of using a larger cable, $/year (see Note 3)

NOTES:

1 *n* is assumed to be the time period the entity that pays the capital costs accrues benefits from the savings due to the selection of a larger cable size. For a domestic situation this time period is the average time first home owners stay in the home (~7 years). An appropriate time period should be used for commercial installations. In this commercial or industrial example the time period is assumed to be 20 years. If the calculated payback period is longer than 20 years then the cable size will not be economically viable. The time period (n) is not to be confused with the payback period (N), which is a particular instance of n when the NPV_{total} is equal to 0.

2 The discount rate (r) is the expected rate of return that those paying for the energy losses (home or building owner) could earn for a similar risk in financial markets. In this example it has been set to 7% (expressed as 0.07, not 1.07).

3 Value of annual energy savings from reduced I^2R loss—unit cost of electricity is assumed to be constant for the time period.

4 The Microsoft Excel® spreadsheet *NPV* function is not used as it does not allow for constant cash flows over a set period of time. The Microsoft Excel® *NPV* function requires each year's cash flow to be worked out and entered separately into the function.

Equation A9.2 can be solved to determine the NPV_{total} of selecting the next larger cable size to 120 mm²:

$$NPV_{\text{total}} = \frac{433\left(1-(1+0.07)^{-20}\right)}{0.07} - 905 = \$3692 \quad \text{. . . A9.3(5)}$$

NOTE: The way the intermediate results are rounded may influence the NPV_{total}. For example, if the rounded values of 433 and 905 are used NPV_{total} is $3682. When unrounded numbers are used, the NPV_{total} is $3692.

Step 5 Calculation of the payback period

The payback period (N) represents the number of years that the accumulated savings of reduced losses equals the additional cost of installing a larger cable size. The payback period is determined when the NPV_{total} is equal to 0. By using Equation A9.3(3) and making NPV_{total} equals zero:

$$NPV_{\text{total}} = NPV_{\text{savings}} - cc$$

$$0 = \frac{Y\left(1+r\right)^{-N}}{r} - cc \qquad \text{. . . A9.3(6)}$$

The above can be rewritten as—

$$N = \frac{-\log\left(1 - \frac{r\,xcc}{y}\right)}{\log\left(1+r\right)} \qquad \text{. . . A9.3(7)}$$

where

N = payback period, in years

As a result of moving one cable size up to 120 mm^2:

Y = 2149 – 1716 = $433; and

cc = 4416 – 3511 = $905

The payback period (N) in this example is therefore:

$$N = \frac{-\log\left(1 - \frac{0.07 \times 905}{433}\right)}{\log\left(1+0.07\right)} = 2.3\,\text{years} \qquad \text{. . . A9.3(8)}$$

The benefit to cost (B/C) ratio for moving one cable size up to 120 mm^2:

= NPV_{total}/cc

= 3692/905 = 4.1

NOTE: The B/C ratio is used as both a ranking indicator and a decision threshold. The B/C ratio should be significantly greater than one for the selection of a larger cable to be worthwhile.

Step 6 Calculation of the properties of increasingly larger cables

Repeat the calculations in Steps 2 to 5 for available cable sizes as shown in the table below or until the NPV_{total} starts to decrease.

TABLE A9.3

SUMMARY OF ALL CALCULATIONS

Phase conductor size	Upfront cost* (3 phase plus earth)	Increase in upfront cost over cost of 95 mm² cable (cc)	I^2R loss of cable (3 phase)	Cost of I^2R loss	I^2R loss savings† (Y)	$NPV_{savings}$ over 20 years ($NPV_{savings}$)	NPV_{total} over 20 years (NPV_{total})	Payback period (N)	Benefit to cost ratio
mm²	$	$	kW	$/year	$/year	$	$	year	
95	3 511	—	1.636	2 149	—	—	—	—	—
120	4 416	905	1.306	1 716	434	4 597	3 692	2.3	4.1
150	5 490	1 979	1.060	1 393	757	8 018	6 039	3.0	3.1
185	6 874	3 363	0.852	1 120	1 029	10 905	7 542	3.8	2.2
240	8 996	5 485	0.662	870	1 280	13 556	8 071	5.3	1.5
300	11 260	7 749	0.540	709	1 440	15 256	7 507	7.0	1.0
400	13 854	10 343	0.437	574	1 575	16 689	6 346	9.1	0.6
500	17 513	14 002	0.359	471	1 678	17 779	3 777	13.0	0.3
630	22 278	18 767	0.299	393	1 757	18 613	−154	20.4	0.0

* The nonlinear step-like movements in upfront cost price are due to selection of the earth conductor size relative to the phase conductor size.

† Savings are based on the difference from the 95 mm² case (see Step 1).

Step 7 Selection of economically optimal cable size

All cables with conductor cross-sectional areas from 120 mm² to 240 mm² have a B/C ratio that is greater than unity and their installation would offer lifetime benefits to the owner when compared to the 95 mm² cable. The largest positive value of NPV_{total} is $8071 for the cable with 240 mm² conductor size and therefore is the economically optimal cable size for this example with the assumptions made.

APPENDIX B

LIST OF TABLES

(Informative)

APPENDIX C

EXAMPLES OF THE APPLICATION OF REDUCTION FACTORS FOR HARMONIC CURRENTS

(Informative)

Consider a three-phase circuit with a design load of 40 A to be installed using four-core PVC insulated cable clipped to a wall.

From Table 13, a 6 mm^2 cable with copper conductors has a current-carrying capacity of 42 A, and hence, is suitable if harmonics are not present in the circuit.

If 20% third harmonic is present then a reduction factor of 0.86 is applied and the design load becomes—

$$\frac{40}{0.86} = 47 \text{ A} \qquad \text{. . . C(1)}$$

For this load a 10 mm^2 cable is suitable.

If 44% third harmonic is present the cable size selection is based on the neutral current which is—

$$40 \times 0.44 \times 3 = 52.8 \text{ A} \qquad \text{. . . C(2)}$$

and a reduction factor of 0.86 is applied, leading to a design load of—

$$\frac{52.8}{0.86} = 61.4\ A \qquad \text{. . . C(3)}$$

For this load, a 16 mm^2 cable is suitable.

If 50% third harmonic is present the cable size is again selected on the basis of the neutral current, which is—

$$40 \times 0.5 \times 3 = 60 \text{ A} \qquad \text{. . . C(4)}$$

In this case, the reduction factor is 1 and a 16 mm^2 cable is suitable.

All the above cable selections are based on the current-carrying capacity of the cable only. Voltage drop and other aspects of design have not been considered.

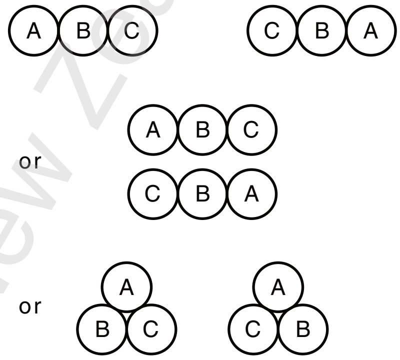
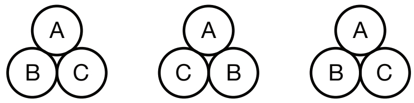
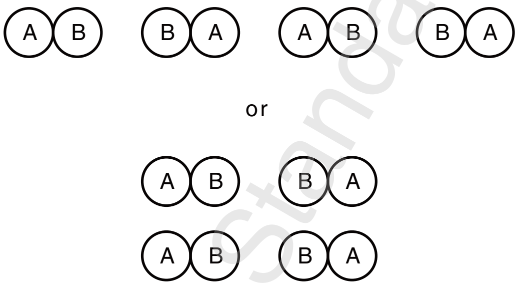
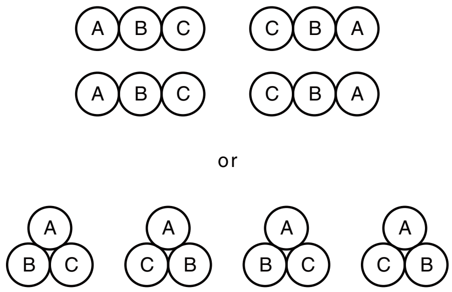
APPENDIX D

RECOMMENDED CIRCUIT CONFIGURATIONS FOR THE INSTALLATION OF SINGLE-CORE CABLES IN PARALLEL

(Informative)

TABLE D1

LOAD CURRENT SHARING CONFIGURATIONS

Mode	Two-phase	Three-phase
Two conductors per phase		
Three conductors per phase	Not recommended	
Four conductors per phase		

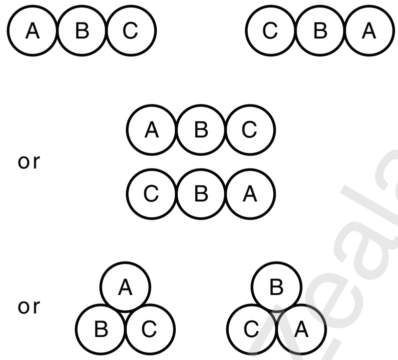
NOTES:

1 Neutral conductors are to be located so as to not disturb the symmetry of the groups as illustrated.

2 Non-symmetrical configuration may cause unequal distribution of current between conductors. Provision should be made to maintain the recommended configurations to avoid these problems.

TABLE D2

LOW MAGNETIC FIELD CONFIGURATIONS

<table>
<tr><th>Mode</th><th>Three-phase</th></tr>
<tr><td>Two conductors per phase</td><td>
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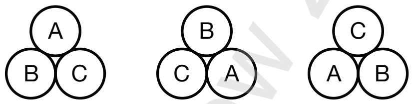
<tr><td>Three conductors per phase</td><td>
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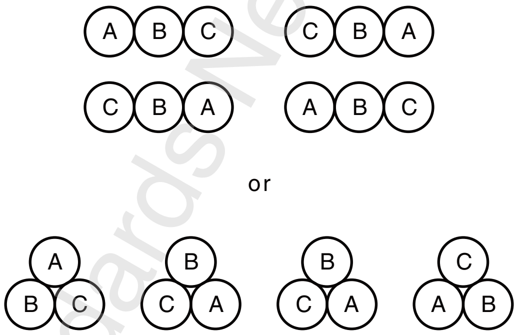
<tr><td>Four conductors per phase</td><td>
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NOTES:

1 The magnetic field generated by parallel groups of single-core cables is complex and its reduction is dependent on a number of factors, the most significant of which are—

(a) the load current in each parallel cable group is assumed to be equal, at least 95% should be maintained; and

(b) the spacing between each parallel cable group is assumed to be small, consistent with the spacings in Figure 1, a spacing of one to two cable diameters should be maintained.

2 Neutral conductors are to be positioned close to phase conductors taking into account symmetry and effect of air circulation.

3 Other group configurations may also achieve relatively low levels of magnetic fields that may be suitable for the specific requirements of the installation.

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