AS/NZS 3008.1.1:2017

Australian/New Zealand Standard™

Electrical installations—Selection of cables

Part 1.1: Cables for alternating voltages up to and including 0.6/1 kV—Typical Australian installation conditions

STANDARDS Australia

STANDARDS® NEW ZEALAND PAEREWA AOTEAROA

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee EL-001, Wiring Rules, to supersede AS/NZS 3008.1.1:2009, *Electrical installations—Selection of cables*, Part 1.1: *Cables for alternating voltages up to and including 0.6/1 kV—Typical Australian installation conditions*.

This Standard is applicable to Australian installation conditions where the nominal ambient air and soil temperatures are 40°C and 25°C, respectively. AS/NZS 3008.1.2 is applicable to New Zealand installation conditions where the nominal air and soil temperatures are 30°C and 15°C respectively. Each Part is a complete Standard and requires no reference to the other.

AS/NZS 3008.1.2 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 2009 edition and its subsequent amendment 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(3).

  (v) Table 3(4).

  (vi) Table 10.

  (vii) Table 11.

  (viii) Table 12.

  (ix) Table 13.

  (x) Table 14.

  (xi) Table 15.

  (xii) Table 17.

  (xiii) 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.

NOTE: Although the Standard specifically applies to a.c. installations, it may also be applied to d.c. installations.

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 Australia. 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
3008.1.2 Part 1.2: Cables for alternating voltages up to and including 0.6/1 kV—Typical New Zealand conditions

IEC
60287 Electric cables—Calculation of the current rating (series)

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	Past 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 Table 22, Table 23 or Table 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 ECONOMIIC 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 do 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 A, Paragraph 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 this 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 (I^2R) 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 40°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 40°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).

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.

7 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 (for example, 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 40°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 trench.

  (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 40°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 25°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 25°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) for 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

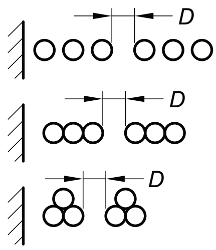
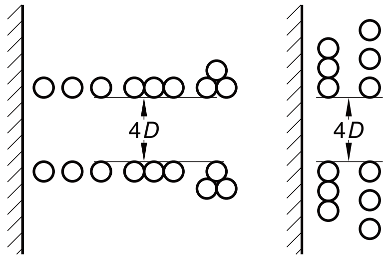
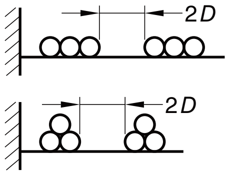
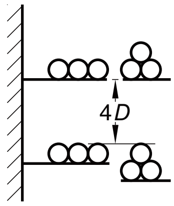
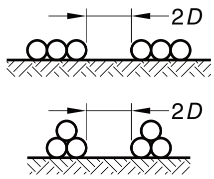
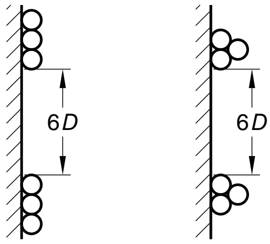
(iii) half the length of the cable,

whichever is the shorter dimension.

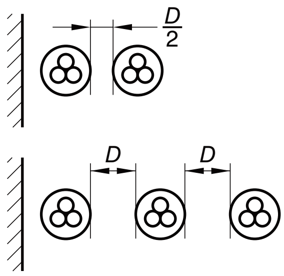
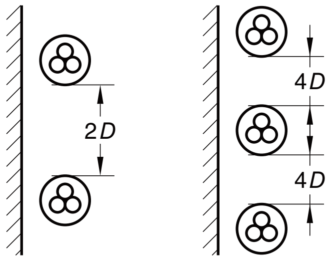
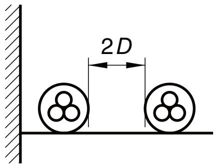
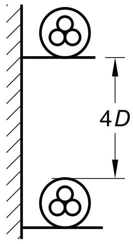
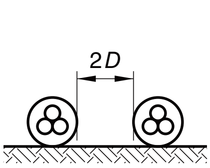
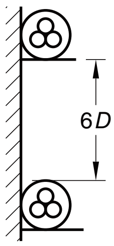
(c) *Groups of circuits in free air* Groups of circuits installed unenclosed under the conditions and circuit arrangements depicted in Figure 1.

(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

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		

(b) Multicore cables

FIGURE 1 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 provided 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 provided 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, Paragraph 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) or, 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 dating factors when circuits are bunched.

NOTE: The selection of the dating 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 dating 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 dating 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 40°C and an ambient soil temperature of 25°C. Where other ambient temperatures apply, the appropriate rating factors shall be as given in Tables 27(1) and 27(2).

NOTES:

1 In New Zealand the conditions of installation specify an ambient temperature of 30°C and a soil temperature of 15°C. A complete set of current rating tables, calculated for New Zealand conditions, is given in AS/NZS 3008.1.2.

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 40°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 lying of 0.5 m as specified in Clauses 3.4.4 and 3.4.5. Where other depths of lying 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 for 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

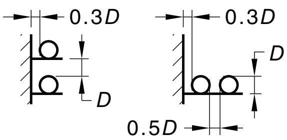
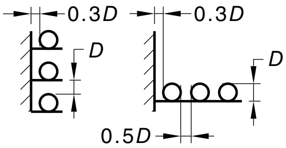
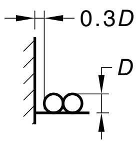
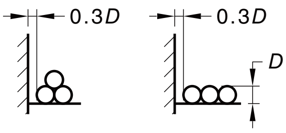
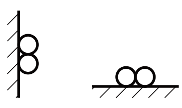
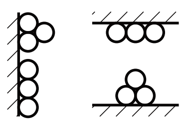
(b) installation of cables in enclosures that contain or shield magnetic fields; or

(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.

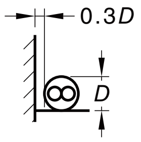
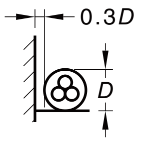
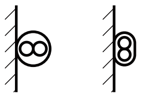
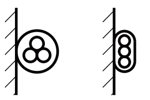
TABLE 3(1)

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—	23
2	Three single-core cables		Tables 7 and 8 Columns 2 to 4 Table 9 Columns 2 and 3	(a) spaced from a wall or vertical surface; (b) supported on ladders, racks, perforated trays, cleats or hanger; or	
3				(c) suspended from a catenary wire.	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;	23
5	Three single-core cables		Tables 7 and 8 (see Note 5) Columns 5 to 7 Table 9 Columns 4 and 5	(b) supported on ladders, racks, perforated or unperforated trays, cleats or hangers; (c) in a switchboard or similar enclosure; or	
6				(d) supported from a catenary wire.	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;	22
8	Three single-core cables		Tables 7 and 8 (see Note 4) Columns 8 to 10 Table 9 Columns 6 and 7.	(c) buried directly in a plaster or render on a wall; or (d) in a switchboard or similar enclosure.	

(*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.

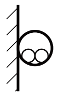
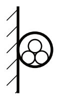
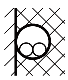
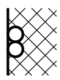
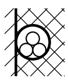
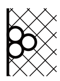
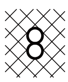
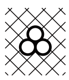
4 See Table 22 for the derating factor applicable to a single circuit fixed to the underside of a ceiling or similar horizontal surface.

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.

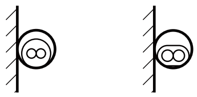
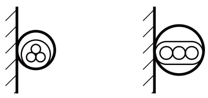
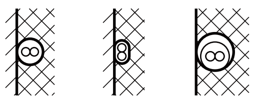
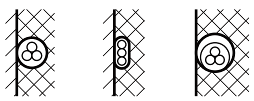
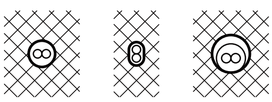
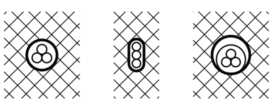
TABLE 3(2)

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.	
2	Three single-core cables		Tables 7 and 8 Columns 15 to 17 Table 9 Columns 11 and 12	Cables installed in— (a) a wiring enclosure on a wall; or (b) an enclosed trench with a removable cover.	
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:

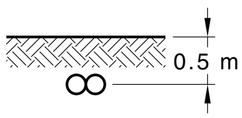
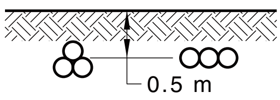
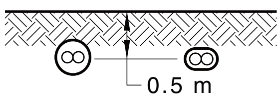
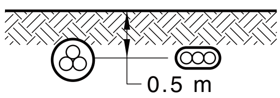
1 Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be counted in the number of cable cores.

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

<table>
<tr><th>1</th><th>2</th><th>3</th><th>4</th><th>5</th><th>6</th></tr>
<tr><th>Item No.</th><th>Cable details (see Note 1)</th><th>Reference drawing (see Note 2)</th><th>Current-carrying capacity table reference</th><th>Methods of installation for cables deemed to have the same current-carrying capacity (see Note 3)</th><th>Derating table</th></tr>
<tr><td>1</td><td>Two single-core cables</td><td>
</td><td>Tables 4 and 5
Columns 22 and 23
Table 6
Column 15</td><td rowspan="4">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.</td><td rowspan="2">25(1)</td></tr>
<tr><td>2</td><td>Three single-core cables</td><td>
</td><td>Tables 7 and 8
Columns 22 and 23
Table 9
Column 15</td></tr>
<tr><td>3</td><td>Two-core cables</td><td>
</td><td>Tables 10 and 11
Columns 23 and 24
Table 12
Column 13</td><td rowspan="2">25(2)</td></tr>
<tr><td>4</td><td>Three-core cables</td><td>
</td><td>Tables 13 and 14
Columns 23 and 24
Table 15
Column 13</td></tr>
</table>

NOTES:

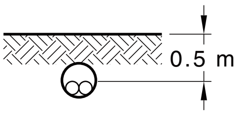
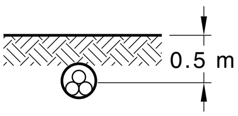
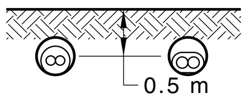
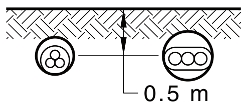
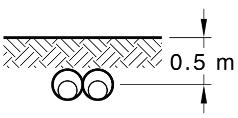
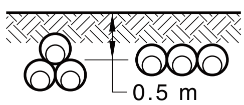
1 Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be counted in the number of cable cores.

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	
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**	
					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.

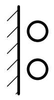
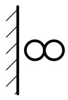
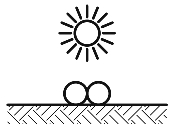
TABLE 4
CURRENT-CARRYING CAPACITIES

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

INSULATION TYPE: THERMOPLASTIC (See Note 2)

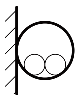
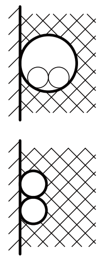
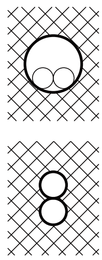
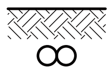
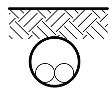
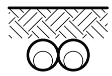
MAXIMUM CONDUCTOR TEMPERATURE: 75°C

REFERENCE AMBIENT TEMPERATURE: 40°C IN AIR, 25°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	16	17	—	16	17	—	13	13	—	8	8	—
1.5	21	21	—	21	21	—	16	17	—	10	10	—
2.5	30	29	—	29	28	—	23	22	—	13	13	—
4	40	38	—	39	38	—	31	30	—	18	17	—
6	51	49	—	49	48	—	40	38	—	22	21	—
10	69	69	—	67	67	—	54	54	—	30	29	—
16	92	91	72	89	88	69	72	71	56	39	38	30
25	124	121	96	119	115	92	97	94	75	50	49	39
35	153	150	119	145	143	113	119	117	92	61	59	47
50	187	189	145	177	179	137	146	147	113	72	73	56
70	238	238	184	223	224	173	184	185	143	89	89	69
95	295	287	229	276	269	214	230	223	178	107	104	83
120	344	341	267	321	317	249	267	265	208	122	120	95
150	395	393	307	367	365	285	308	306	239	137	135	106
185	459	450	357	424	416	331	358	351	279	154	150	120
240	549	541	427	505	498	394	428	422	334	177	173	138
300	636	624	495	582	571	456	495	486	388	198	192	155
400	744	752	583	676	682	535	577	583	456	221	218	175
500	867	876	685	780	787	624	668	675	535	245	240	196
630	1014	1036	808	897	914	730	770	785	627	269	266	219

(*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**
mm^2	**Solid/ Stranded**	**Flexible**								**Solid/ Stranded**	**Flexible**			
1	13	14	—	11	—	6	—	18	—	18	19	—	21	—
1.5	18	18	—	14	—	8	—	23	—	23	23	—	26	—
2.5	24	24	—	20	—	12	—	32	—	32	31	—	36	—
4	32	31	—	25	—	16	—	41	—	41	40	—	47	—
6	41	40	—	33	—	20	—	52	—	52	50	—	58	—
10	54	54	—	44	—	27	—	69	—	69	68	—	77	—
16	70	69	54	56	43	36	28	122	95	89	87	69	99	77
25	94	91	73	75	58	48	37	158	123	116	112	90	129	100
35	112	110	87	90	70	59	46	190	147	139	136	108	155	120
50	138	139	107	110	86	—	—	225	174	168	168	130	186	145
70	170	169	132	136	105	—	—	277	215	206	205	160	228	177
95	212	206	164	169	131	—	—	332	257	252	244	195	278	215
120	242	237	188	193	150	—	—	378	294	287	282	223	316	245
150	282	278	219	225	175	—	—	424	329	329	324	255	354	274
185	320	312	249	256	199	—	—	480	374	373	363	291	408	317
240	381	373	298	305	238	—	—	556	434	438	429	342	472	368
300	—	—	—	—	—	—	—	628	491	496	493	388	546	425
400	—	—	—	—	—	—	—	713	564	575	572	454	621	487
500	—	—	—	—	—	—	—	805	644	649	663	520	721	570
630	—	—	—	—	—	—	—	904	737	750	754	611	816	652

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 40°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 40°C ambient air temperature and 25°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

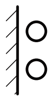
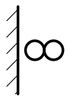
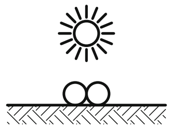
CURRENT-CARRYING CAPACITIES

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

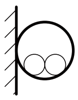
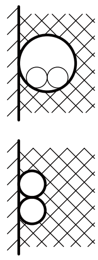
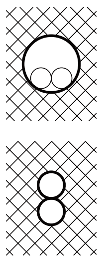
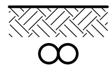
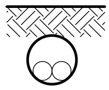
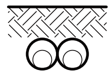
MAXIMUM CONDUCTOR TEMPERATURE: 90°C (See Note 2)

REFERENCE AMBIENT TEMPERATURE: 40°C IN AIR, 25°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	20	21	—	20	21	—	16	16	—	12	13	—
1.5	26	26	—	25	26	—	20	20	—	15	16	—
2.5	36	35	—	36	34	—	28	27	—	21	21	—
4	48	46	—	47	46	—	37	36	—	28	27	—
6	61	59	—	60	58	—	47	46	—	36	34	—
10	84	83	—	82	81	—	65	64	—	48	48	—
16	112	110	87	108	106	84	86	85	67	64	63	50
25	151	147	117	145	141	112	117	114	91	86	83	66
35	186	183	144	177	174	137	144	141	111	105	103	81
50	228	231	177	216	218	167	176	178	136	127	128	99
70	291	292	226	273	274	212	224	225	174	160	161	124
95	361	351	280	338	328	262	278	271	216	197	192	153
120	422	418	328	393	389	305	325	322	253	229	226	178
150	486	483	377	451	448	350	375	373	291	262	260	204
185	565	555	439	522	512	406	436	428	340	303	296	236
240	678	668	527	622	613	485	522	515	408	359	353	280
300	787	772	612	718	705	562	605	594	473	413	404	323
400	923	933	723	836	843	660	708	715	559	478	480	377
500	1078	1090	850	966	975	772	821	830	656	550	552	439
630	1261	1288	1003	1113	1135	904	950	969	772	629	639	511

(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**
mm²	**Solid/ Stranded**	**Flexible**								**Solid/ Stranded**	**Flexible**			
1	16	17	—	13	—	8	—	20	—	20	21	—	24	—
1.5	21	21	—	16	—	10	—	26	—	26	26	—	30	—
2.5	30	28	—	24	—	14	—	36	—	36	35	—	41	—
4	38	37	—	30	—	19	—	46	—	46	45	—	53	—
6	47	46	—	38	—	24	—	58	—	58	56	—	66	—
10	65	64	—	52	—	32	—	78	—	78	77	—	87	—
16	84	82	65	67	52	43	33	139	107	100	98	78	112	87
25	113	109	87	90	70	58	45	179	139	131	127	102	146	114
35	135	132	105	108	84	72	56	215	167	157	154	122	175	136
50	166	167	129	133	103	—	—	255	198	189	190	147	211	164
70	204	204	159	164	127	—	—	313	243	233	232	181	258	200
95	255	248	198	204	158	—	—	375	291	285	276	221	309	239
120	292	286	226	233	181	—	—	427	332	325	319	252	358	278
150	329	336	255	263	204	—	—	480	372	365	368	283	401	311
185	387	377	301	309	241	—	—	543	423	423	412	329	463	359
240	461	452	360	369	288	—	—	630	492	497	486	388	536	417
300	—	—	—	—	—	—	—	711	556	562	548	440	620	482
400	—	—	—	—	—	—	—	808	638	653	650	516	706	553
500	—	—	—	—	—	—	—	913	729	739	733	590	800	632
630	—	—	—	—	—	—	—	1026	833	856	860	695	930	740

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 40°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 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 40°C ambient air temperature and 25°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.

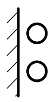
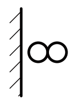
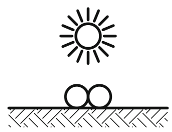
TABLE 6
CURRENT-CARRYING CAPACITIES

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

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

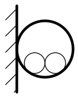
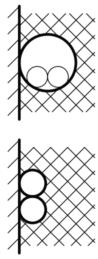
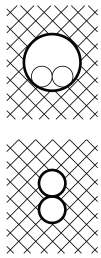
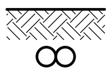
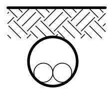
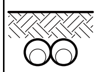
MAXIMUM CONDUCTOR TEMPERATURE: 110°C

REFERENCE AMBIENT TEMPERATURE: 40°C IN AIR, 25°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	25	26	24	26	20	21	17	18
1.5	32	32	31	32	25	26	21	22
2.5	45	43	44	42	36	34	30	29
4	59	57	58	56	47	45	39	38
6	75	73	73	70	59	57	50	48
10	103	102	99	98	81	80	68	67
16	137	135	131	129	107	105	89	88
25	183	178	175	170	143	139	119	116
35	225	221	214	210	176	172	146	143
50	276	279	261	263	215	218	178	179
70	349	351	328	329	272	273	224	224
95	434	422	406	395	339	329	277	269
120	505	500	471	466	394	390	321	318
150	581	577	540	536	454	450	369	366
185	673	660	624	611	527	516	427	418
240	806	794	743	732	630	621	508	500
300	934	916	857	841	730	716	586	575
400	1094	1105	998	1006	853	860	682	687
500	1278	1290	1155	1164	990	999	789	794
630	1498	1529	1334	1359	1146	1168	909	925

(*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
mm^2	Solid/ Stranded	Flexible				Solid/ Stranded	Flexible	
1	20	21	16	10	23	23	24	26
1.5	25	25	20	13	29	29	30	33
2.5	35	33	28	18	40	40	39	46
4	46	45	37	23	53	53	51	59
6	58	56	46	30	66	66	64	74
10	78	77	62	40	88	88	86	97
16	104	102	83	53	154	115	112	127
25	137	133	109	72	198	148	143	163
35	165	167	132	88	238	177	176	195
50	205	207	164	—	282	214	215	236
70	255	263	204	—	346	262	266	288
95	321	312	257	—	416	321	312	352
120	369	364	296	—	473	366	359	400
150	430	426	344	—	531	420	414	448
185	493	481	394	—	601	477	464	517
240	594	583	476	—	698	561	548	600
300	—	—	—	—	789	648	631	694
400	—	—	—	—	898	738	734	790
500	—	—	—	—	1018	837	855	921
630	—	—	—	—	1148	973	977	1045

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 40°C ambient air temperature and 25°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.

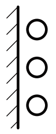
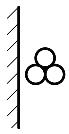
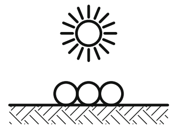
TABLE 7
CURRENT-CARRYING CAPACITIES

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

INSULATION TYPE: THERMOPLASTIC (See Note 2)

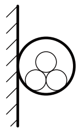
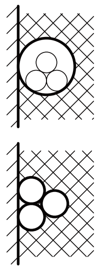
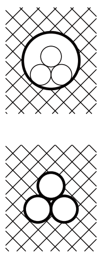
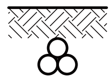
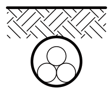
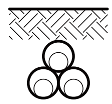
MAXIMUM CONDUCTOR TEMPERATURE: 75°C

REFERENCE AMBIENT TEMPERATURE: 40°C IN AIR, 25°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	16	16	—	14	14	—	13	13	—	8	8	—
1.5	20	21	—	17	18	—	16	17	—	10	10	—
2.5	29	27	—	25	24	—	23	22	—	13	13	—
4	38	37	—	33	32	—	31	30	—	18	17	—
6	49	47	—	42	41	—	40	38	—	22	21	—
10	67	66	—	58	57	—	54	54	—	30	29	—
16	89	88	69	77	75	59	72	71	56	39	38	30
25	120	117	93	103	100	80	97	94	75	50	49	39
35	148	145	115	127	125	98	119	117	92	61	59	47
50	181	183	141	156	157	121	146	147	113	72	73	56
70	230	231	179	197	198	153	184	185	143	89	89	69
95	287	279	222	246	239	191	230	223	178	107	104	83
120	335	331	260	287	284	223	267	264	208	122	120	95
150	385	383	298	330	328	256	308	305	239	137	135	106
185	447	438	347	383	376	299	357	350	278	154	149	120
240	535	528	417	457	451	358	426	420	334	176	172	138
300	620	609	483	529	519	415	492	484	387	197	191	155
400	726	734	570	615	621	488	573	578	455	219	216	175
500	846	855	669	710	717	571	661	668	532	242	237	196
630	990	1011	789	817	833	668	760	775	622	265	262	219

(*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
mm^2	Solid/ Stranded	Flexible								Solid/ Stranded	Flexible			
1	12	13	—	10	—	6	—	16	—	16	16	—	19	—
1.5	15	15	—	12	—	8	—	20	—	20	20	—	24	—
2.5	21	20	—	17	—	12	—	27	—	27	26	—	33	—
4	28	27	—	23	—	16	—	36	—	36	35	—	43	—
6	35	34	—	28	—	20	—	45	—	45	43	—	53	—
10	47	46	—	37	—	27	—	59	—	59	58	—	70	—
16	62	61	48	50	39	36	28	104	81	78	76	60	90	70
25	81	78	63	64	50	48	38	134	104	100	97	78	117	91
35	100	98	78	80	62	59	46	160	124	122	119	94	140	108
50	119	120	92	95	74	—	—	190	147	144	145	112	168	131
70	152	152	118	122	94	—	—	233	181	180	180	140	205	159
95	183	178	142	147	114	—	—	279	216	217	210	168	250	194
120	217	213	169	173	135	—	—	317	247	252	247	196	283	220
150	244	241	190	195	152	—	—	356	276	283	279	220	317	246
185	284	277	222	227	177	—	—	402	313	325	316	253	365	284
240	331	336	269	265	207	—	—	465	364	377	376	295	422	329
300	388	379	305	311	244	—	—	524	412	434	423	341	488	380
400	442	461	351	353	281	—	—	593	471	492	504	391	553	434
500	523	520	421	418	337	—	—	668	537	571	566	459	641	507
630	588	592	481	471	385	—	—	748	612	639	641	523	723	578

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 40°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 40°C ambient air temperature and 25°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

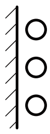
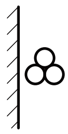
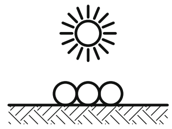
CURRENT-CARRYING CAPACITIES

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

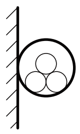
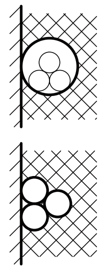
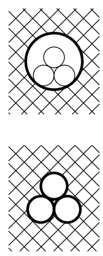
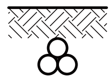
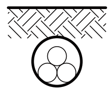
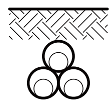
MAXIMUM CONDUCTOR TEMPERATURE: 90°C AND 105°C (See Note 2)

REFERENCE AMBIENT TEMPERATURE: 40°C IN AIR, 25°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	19	20	—	16	17	—	16	16	—	12	13	—
1.5	25	25	—	21	22	—	20	20	—	15	16	—
2.5	35	33	—	30	29	—	28	27	—	21	21	—
4	46	45	—	40	38	—	37	36	—	28	27	—
6	59	57	—	50	49	—	47	46	—	36	34	—
10	81	80	—	69	69	—	65	64	—	48	48	—
16	108	106	84	92	91	71	86	85	67	64	63	50
25	146	142	113	125	121	97	117	114	91	86	83	66
35	180	177	140	154	151	119	144	141	111	105	103	81
50	221	223	171	188	191	146	176	178	136	127	128	99
70	282	283	219	240	241	186	224	225	174	160	161	124
95	350	341	271	298	290	232	278	271	216	197	192	153
120	410	406	318	349	346	271	325	322	253	229	226	178
150	472	470	366	403	400	313	375	372	291	262	260	203
185	550	540	427	468	459	365	435	427	339	302	296	235
240	660	651	513	560	553	438	521	514	407	358	352	280
300	766	752	596	648	637	508	602	591	472	410	402	322
400	899	909	705	756	764	599	702	709	557	474	477	376
500	1051	1062	829	874	884	703	812	821	652	544	546	437
630	1230	1256	978	1010	1030	824	938	956	765	621	630	507

(*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	Flexible								Solid/ Stranded	Flexible			
1	15	15	—	12	—	8	—	18	—	18	19	—	22	—
1.5	18	19	—	15	—	10	—	22	—	22	23	—	27	—
2.5	25	24	—	20	—	14	—	31	—	31	30	—	38	—
4	33	31	—	26	—	19	—	40	—	40	38	—	49	—
6	42	41	—	34	—	24	—	50	—	50	49	—	60	—
10	56	55	—	45	—	32	—	67	—	67	66	—	79	—
16	72	73	56	58	45	43	33	117	91	86	85	66	101	79
25	97	94	75	77	60	58	45	151	117	113	109	87	132	103
35	120	118	93	96	75	72	56	180	140	137	134	106	158	122
50	143	144	111	114	89	—	—	214	166	163	163	126	190	147
70	183	183	142	146	114	—	—	262	203	203	203	158	232	180
95	220	214	171	176	137	—	—	313	243	244	237	190	276	214
120	261	256	203	209	162	—	—	356	277	284	279	221	320	248
150	295	291	229	236	183	—	—	400	310	320	316	249	358	277
185	335	334	261	268	209	—	—	452	352	363	357	283	413	321
240	399	391	312	320	250	—	—	523	409	426	416	333	477	371
300	469	458	368	375	294	—	—	589	463	491	479	385	552	430
400	534	533	424	427	339	—	—	668	530	557	554	442	626	491
500	633	630	509	506	407	—	—	752	604	648	642	520	707	559
630	714	719	583	571	466	—	—	843	688	727	729	593	820	654

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 40°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 40°C ambient air temperature and 25°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

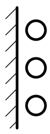
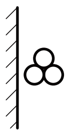
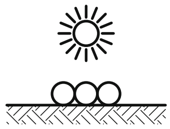
CURRENT-CARRYING CAPACITIES

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

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

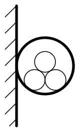
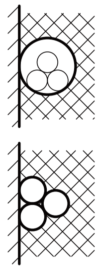
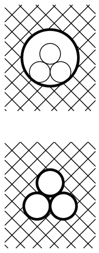
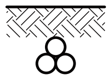
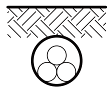
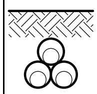
MAXIMUM CONDUCTOR TEMPERATURE: 110°C

REFERENCE AMBIENT TEMPERATURE: 40°C IN AIR, 25°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	24	25	21	22	20	21	17	18
1.5	31	31	27	27	25	26	21	22
2.5	43	42	38	36	36	34	30	29
4	57	55	50	48	47	45	39	38
6	73	70	63	61	59	57	50	48
10	99	99	86	85	81	80	68	67
16	132	130	114	112	107	105	89	88
25	177	173	153	149	143	139	119	116
35	218	214	188	184	176	172	146	143
50	267	270	230	233	215	217	178	179
70	339	340	291	292	272	273	224	224
95	422	410	363	353	339	329	277	269
120	492	487	422	418	394	390	321	317
150	565	562	486	482	453	450	368	365
185	656	644	564	553	526	516	426	417
240	786	775	674	665	629	620	507	499
300	912	895	780	766	727	714	584	572
400	1069	1079	910	918	847	855	678	682
500	1248	1260	1053	1064	981	990	782	786
630	1462	1493	1217	1240	1132	1154	898	913

(*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
mm^2	Solid/ Stranded	Flexible				Solid/ Stranded	Flexible	
1	17	18	14	10	20	20	21	24
1.5	22	23	18	13	25	25	26	30
2.5	32	31	25	18	36	36	34	42
4	41	40	33	23	46	46	44	54
6	51	50	41	30	57	57	55	67
10	71	70	57	40	77	77	76	88
16	93	91	74	53	130	99	97	115
25	125	121	100	72	168	130	125	148
35	151	148	121	88	201	155	151	176
50	182	190	146	—	237	184	188	212
70	234	234	187	—	291	230	229	259
95	285	277	228	—	348	277	268	315
120	337	331	269	—	396	322	316	357
150	382	378	306	—	445	362	357	400
185	449	438	359	—	503	415	404	461
240	548	538	439	—	583	492	481	533
300	626	612	501	—	657	556	542	617
400	718	757	575	—	746	631	648	700
500	865	864	692	—	843	736	729	815
630	983	993	787	—	947	827	828	920

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).

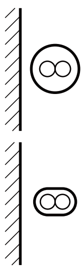
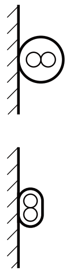
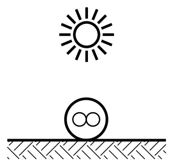
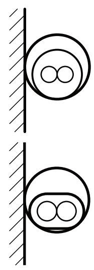
4 To determine the three-phase voltage drop of these configurations, refer to the appropriate value in Table 40, Table 41 or Table 46.

5 These ratings are based on 40°C ambient air temperature and 25°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.

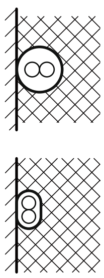
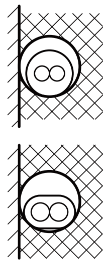
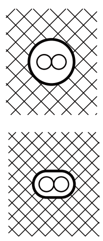
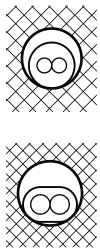
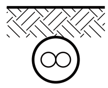
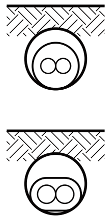
TABLE 10
CURRENT-CARRYING CAPACITIES

CABLE TYPE:	**TWO-CORE SHEATHED (See Note 1)**
INSULATION TYPE:	**THERMOPLASTIC (See Note 2)**
MAXIMUM CONDUCTOR TEMPERATURE:	**75°C**
REFERENCE AMBIENT TEMPERATURE:	**40°C IN AIR, 25°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		A1	Cu		A1	Cu		A1
mm^2	Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible	
1	15	16	—	14	15	—	11	12	—	13	13	—
1.5	19	20	—	18	18	—	14	14	—	16	17	—
2.5	27	26	—	26	25	—	20	19	—	23	23	—
4	37	35	—	34	33	—	27	26	—	30	29	—
6	46	45	—	44	42	—	34	32	—	39	38	—
10	64	63	—	60	59	—	46	45	—	52	51	—
16	85	83	66	80	78	62	60	59	47	68	68	52
25	113	110	88	107	104	83	79	77	62	90	87	70
35	139	137	108	131	128	101	97	94	75	112	109	87
50	170	171	132	159	161	124	116	117	90	133	134	103
70	215	215	167	201	202	156	145	145	112	170	169	132
95	265	257	205	248	241	192	175	170	136	204	198	158
120	307	304	239	288	285	224	202	199	157	241	236	187
150	351	348	272	328	326	255	227	225	177	271	267	210
185	403	395	314	377	370	294	258	252	201	313	305	244
240	477	470	373	446	439	349	300	294	235	364	368	285
300	547	537	429	511	502	401	339	331	266	424	415	333
400	631	636	500	589	593	467	384	384	305	482	500	383
500	716	728	575	668	678	536	429	431	345	561	564	451

(*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		
mm^2	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Solid/ Stranded**	**Flexible**	**Al**
1	11	—	10	—	7	—	6	—	17	—	17	18	—
1.5	14	—	13	—	9	—	8	—	21	—	21	22	—
2.5	20	—	19	—	13	—	12	—	30	—	30	29	—
4	27	—	24	—	17	—	15	—	39	—	39	38	—
6	35	—	31	—	22	—	20	—	50	—	50	48	—
10	48	—	42	—	30	—	26	—	66	—	66	65	—
16	64	49	54	42	40	31	34	26	114	88	86	85	66
25	85	66	72	56	53	41	45	35	147	114	112	108	87
35	105	81	90	70	65	51	56	43	178	138	136	133	106
50	127	99	107	83	—	—	—	—	211	163	162	163	126
70	161	125	136	105	—	—	—	—	259	201	202	202	157
95	198	154	163	127	—	—	—	—	311	241	243	236	189
120	230	179	192	150	—	—	—	—	355	276	282	277	220
150	263	204	217	168	—	—	—	—	398	309	317	313	246
185	302	235	250	195	—	—	—	—	449	350	363	353	283
240	357	279	291	228	—	—	—	—	520	406	421	419	329
300	409	321	340	266	—	—	—	—	586	460	483	472	379
400	471	373	386	306	—	—	—	—	663	526	548	560	434
500	534	429	449	360	—	—	—	—	741	595	628	629	504

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 40°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 40°C ambient air temperature and 25°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.

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

TABLE 11

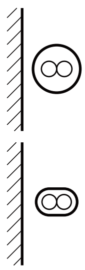
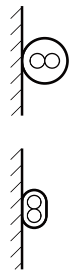
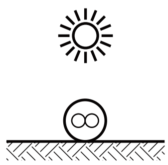
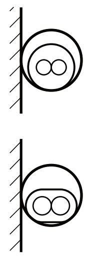
CURRENT-CARRYING CAPACITIES

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

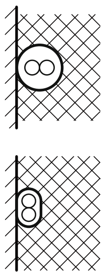
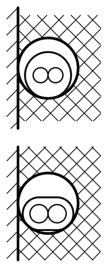
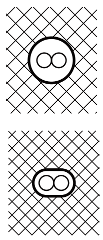
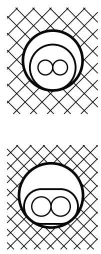
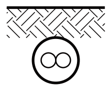
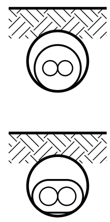
MAXIMUM CONDUCTOR TEMPERATURE: 90°C AND 105°C (See Note 2)

REFERENCE AMBIENT TEMPERATURE: 40°C IN AIR, 25°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	18	19	—	17	18	—	15	16	—	16	16	—
1.5	24	24	—	22	23	—	19	20	—	20	20	—
2.5	34	32	—	31	30	—	27	26	—	28	27	—
4	45	43	—	42	40	—	36	35	—	37	35	—
6	57	55	—	53	51	—	46	44	—	46	44	—
10	78	78	—	73	72	—	63	62	—	63	62	—
16	104	103	81	97	96	75	83	82	64	82	80	63
25	140	136	109	131	128	102	111	108	86	110	106	85
35	173	169	134	162	158	125	136	134	106	132	129	102
50	211	213	163	197	199	153	165	167	128	162	163	126
70	268	269	208	250	251	194	208	209	162	200	207	155
95	331	322	257	309	300	239	255	248	198	250	242	194
120	385	381	299	359	355	279	295	292	230	285	289	222
150	441	438	342	411	408	319	336	333	261	332	328	257
185	509	499	396	473	464	369	385	377	300	377	375	293
240	604	596	472	562	554	439	454	446	354	448	439	350
300	694	682	544	645	633	505	518	507	406	523	511	410
400	804	811	636	745	751	590	594	597	470	596	595	472
500	915	932	734	848	862	680	671	679	538	695	699	557

(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	14	—	12	—	9	—	8	—	19	—	19	20	—
1.5	18	—	16	—	11	—	10	—	24	—	24	25	—
2.5	25	—	23	—	16	—	14	—	34	—	34	33	—
4	33	—	29	—	21	—	18	—	45	—	45	43	—
6	42	—	37	—	27	—	23	—	56	—	56	54	—
10	58	—	51	—	36	—	32	—	75	—	75	74	—
16	78	60	66	51	49	38	41	32	132	102	98	95	75
25	105	81	88	68	66	51	55	43	170	132	128	124	99
35	129	100	106	82	81	63	66	51	205	159	154	150	119
50	158	122	130	101	—	—	—	—	244	189	185	186	144
70	200	155	160	124	—	—	—	—	300	233	228	231	177
95	247	192	200	155	—	—	—	—	360	279	279	271	216
120	287	223	228	177	—	—	—	—	410	319	318	318	247
150	328	255	265	206	—	—	—	—	460	357	365	360	283
185	379	295	301	235	—	—	—	—	520	405	413	407	322
240	449	351	358	280	—	—	—	—	603	471	485	475	379
300	516	404	418	328	—	—	—	—	680	533	558	544	437
400	596	472	477	378	—	—	—	—	771	610	633	631	501
500	678	544	556	446	—	—	—	—	862	691	728	729	583

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 40°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 40°C ambient air temperature and 25°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.

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

TABLE 12

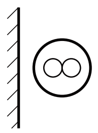
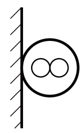
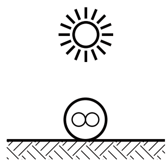
CURRENT-CARRYING CAPACITIES

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

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

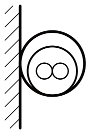
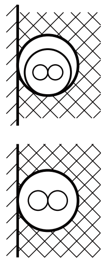
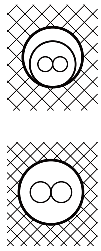
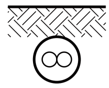
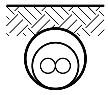
MAXIMUM CONDUCTOR TEMPERATURE: 110°C

REFERENCE AMBIENT TEMPERATURE: 40°C IN AIR, 25°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	23	24	22	23	20	21
1.5	29	30	28	28	25	26
2.5	41	40	39	38	36	34
4	55	53	51	50	47	45
6	69	67	65	63	59	57
10	95	94	89	88	81	80
16	126	124	118	116	107	105
25	168	163	158	154	142	138
35	206	202	194	190	174	170
50	251	254	236	238	211	213
70	317	318	298	299	265	266
95	392	381	367	357	326	317
120	455	450	426	421	377	372
150	519	515	486	482	429	425
185	598	586	559	547	491	481
240	708	698	662	652	580	570
300	815	799	760	745	664	650
400	941	949	878	884	763	767
500	1074	1091	1000	1014	866	877

(*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	19	20	15	11	22	22	23
1.5	24	24	19	14	28	28	29
2.5	33	32	27	19	39	39	37
4	45	43	36	26	51	51	49
6	56	54	45	33	64	64	62
10	76	75	60	45	85	85	84
16	102	100	81	59	145	111	109
25	133	129	107	79	188	144	139
35	166	163	133	97	226	175	171
50	200	202	160	—	268	208	209
70	256	257	205	—	330	260	259
95	312	303	250	—	396	313	304
120	368	362	294	—	452	363	357
150	417	412	333	—	507	409	403
185	486	474	389	—	573	468	456
240	588	577	470	—	665	554	541
300	670	656	536	—	751	626	611
400	768	801	615	—	853	711	727
500	905	913	724	—	957	819	820

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.

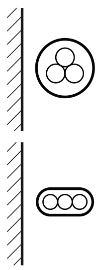
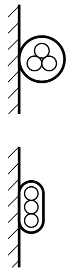
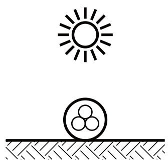
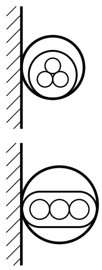
5 These ratings are based on 40°C ambient air temperature and 25°C ambient soil temperature. For other conditions, see Clause 3.5.3.

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

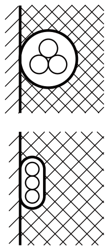
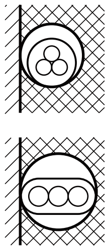
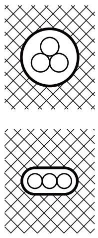
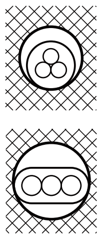
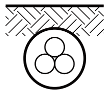
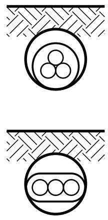
CURRENT-CARRYING CAPACITIES

CABLE TYPES:	**THREE-CORE AND FOUR-CORE (See Note 1)**
INSULATION TYPE:	**THERMOPLASTIC (See Note 2)**
MAXIMUM CONDUCTOR TEMPERATURE:	**75°C**
REFERENCE AMBIENT TEMPERATURE:	**40°C IN AIR, 25°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	13	13	—	12	13	—	9	10	—	11	11	—
1.5	16	17	—	15	16	—	12	12	—	14	14	—
2.5	23	22	—	22	21	—	17	16	—	20	19	—
4	31	30	—	29	28	—	23	22	—	25	24	—
6	40	38	—	37	36	—	29	28	—	33	32	—
10	54	54	—	51	51	—	39	38	—	44	43	—
16	72	71	56	68	67	53	51	50	40	58	57	45
25	97	94	75	91	89	71	67	65	52	76	73	59
35	120	117	93	112	110	87	82	80	64	94	92	73
50	146	148	113	137	138	106	99	100	77	112	112	87
70	185	185	143	172	173	134	123	123	96	142	142	111
95	228	222	177	213	207	165	150	145	116	177	172	137
120	265	262	206	247	244	192	172	169	134	202	199	157
150	303	301	235	282	280	219	194	192	151	228	229	177
185	348	342	272	324	318	253	220	215	172	263	257	206
240	412	407	323	383	378	301	256	251	200	316	309	248
300	472	464	372	438	430	345	288	282	227	—	—	—
400	544	549	434	504	508	402	326	326	260	—	—	—
500	616	627	498	571	580	461	363	365	294	—	—	—

(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		
mm^2	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Cu**	**Al**	**Solid/ Stranded**	**Flexible**	**Al**
1	9	—	9	—	6	—	5	—	14	—	14	15	—
1.5	12	—	11	—	8	—	7	—	18	—	18	18	—
2.5	17	—	16	—	11	—	10	—	25	—	25	24	—
4	23	—	20	—	15	—	13	—	33	—	33	32	—
6	30	—	26	—	19	—	16	—	42	—	42	40	—
10	41	—	35	—	25	—	22	—	55	—	55	54	—
16	54	42	47	36	34	26	29	23	96	75	73	71	56
25	73	57	60	47	46	35	38	29	125	97	94	91	73
35	90	69	75	58	56	43	47	36	150	117	114	112	89
50	109	85	89	69	—	—	—	—	178	138	136	137	105
70	138	107	114	88	—	—	—	—	219	170	170	169	132
95	170	132	142	110	—	—	—	—	263	204	208	201	161
120	198	154	162	126	—	—	—	—	300	233	237	232	184
150	226	175	182	142	—	—	—	—	336	261	266	265	207
185	259	203	211	165	—	—	—	—	379	296	304	296	237
240	307	240	253	198	—	—	—	—	438	344	359	351	281
300	—	—	—	—	—	—	—	—	493	388	404	394	318
400	—	—	—	—	—	—	—	—	557	444	468	467	374
500	—	—	—	—	—	—	—	—	620	501	522	523	422

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 40°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 40°C ambient air temperature and 25°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.

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

TABLE 14

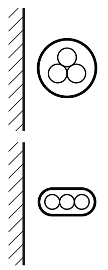
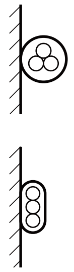
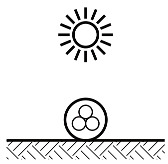
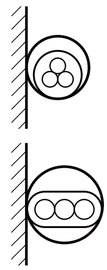
CURRENT-CARRYING CAPACITIES

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

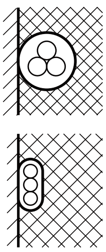
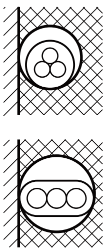
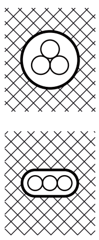
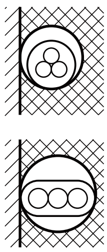
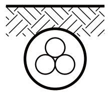
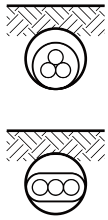
MAXIMUM CONDUCTOR TEMPERATURE: 90°C AND 105°C (See Note 2)

REFERENCE AMBIENT TEMPERATURE: 40°C IN AIR, 25°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
mm^2	Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible	
1	16	16	—	14	15	—	13	13	—	13	14	—
1.5	20	20	—	19	19	—	16	17	—	16	17	—
2.5	28	27	—	26	26	—	23	22	—	24	23	—
4	38	36	—	35	34	—	30	29	—	30	29	—
6	48	46	—	45	43	—	39	37	—	38	37	—
10	66	66	—	62	61	—	53	52	—	53	52	—
16	88	87	68	83	81	64	70	69	54	68	67	53
25	119	116	93	111	108	86	94	92	73	91	89	71
35	147	144	114	137	135	106	115	113	89	114	111	88
50	180	182	140	168	170	130	140	142	109	136	136	105
70	229	230	178	213	214	165	177	177	137	173	173	134
95	283	275	220	263	256	204	217	211	168	209	202	162
120	330	327	256	306	303	238	251	248	195	246	242	192
150	377	375	293	350	348	272	285	283	222	277	274	216
185	436	428	340	404	396	315	327	320	255	322	314	251
240	517	511	405	479	472	375	385	379	302	386	379	303
300	594	584	467	549	539	432	439	430	345	—	—	—
400	685	692	546	632	638	504	502	504	400	—	—	—
500	779	794	629	718	730	579	566	573	457	—	—	—

(*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	12	—	10	—	7	—	6	—	16	—	16	17	—
1.5	15	—	13	—	9	—	8	—	20	—	20	21	—
2.5	21	—	19	—	13	—	12	—	29	—	29	28	—
4	28	—	24	—	18	—	15	—	37	—	37	36	—
6	36	—	30	—	22	—	19	—	46	—	46	45	—
10	49	—	42	—	31	—	26	—	63	—	63	62	—
16	66	51	55	42	41	32	34	26	110	85	81	79	63
25	89	69	73	57	56	43	46	36	143	111	107	103	83
35	110	85	91	71	69	53	57	44	172	133	130	127	101
50	134	104	108	84	—	—	—	—	204	159	155	155	120
70	170	132	138	107	—	—	—	—	251	195	193	193	150
95	210	163	167	129	—	—	—	—	302	234	233	226	181
120	245	190	197	153	—	—	—	—	344	267	270	266	210
150	280	218	222	172	—	—	—	—	385	299	304	300	236
185	323	252	257	201	—	—	—	—	435	340	348	339	272
240	383	300	309	242	—	—	—	—	504	395	411	402	322
300	—	—	—	—	—	—	—	—	567	446	463	452	365
400	—	—	—	—	—	—	—	—	640	510	524	537	417
500	—	—	—	—	—	—	—	—	714	577	601	602	485

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 40°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 40°C ambient air temperature and 25°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.

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

TABLE 15

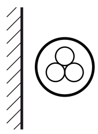
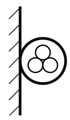
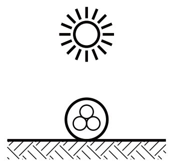
CURRENT-CARRYING CAPACITIES

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

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

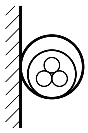
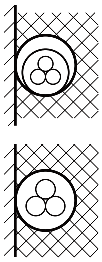
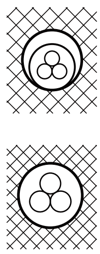
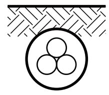
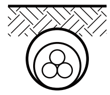
MAXIMUM CONDUCTOR TEMPERATURE: 110°C

REFERENCE AMBIENT TEMPERATURE: 40°C IN AIR, 25°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	20	21	18	19	17	18
1.5	25	26	24	24	22	22
2.5	35	34	33	32	30	29
4	47	45	44	42	40	39
6	59	57	56	54	50	49
10	81	80	76	75	69	68
16	107	106	101	99	91	89
25	144	140	135	131	121	118
35	177	173	166	162	148	145
50	216	218	202	204	180	182
70	272	273	255	255	227	227
95	337	327	314	306	278	271
120	391	387	364	360	322	318
150	447	444	416	413	367	364
185	515	505	479	470	421	412
240	611	602	567	559	496	488
300	701	688	650	638	567	555
400	810	817	751	756	651	655
500	921	936	852	865	737	746

(*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	
mm²	Solid/ Stranded	Flexible				Solid/ Stranded	Flexible
1	16	17	13	9	19	19	20
1.5	20	21	16	12	24	24	24
2.5	29	27	23	17	33	33	31
4	38	36	30	22	43	43	41
6	47	46	38	28	53	53	51
10	64	65	51	38	71	71	71
16	86	84	68	50	122	93	91
25	116	112	93	67	158	122	118
35	140	137	112	83	190	146	143
50	174	175	139	—	226	177	178
70	217	217	173	—	277	217	217
95	270	263	216	—	333	267	259
120	311	306	249	—	379	304	298
150	360	356	288	—	426	346	341
185	411	402	329	—	481	391	381
240	498	489	398	—	558	463	453
300	—	—	—	—	629	522	509
400	—	—	—	—	713	608	606
500	—	—	—	—	797	680	680

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.

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

5 These ratings are based on 40°C ambient air temperature and 25°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).

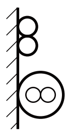
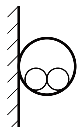
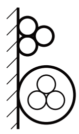
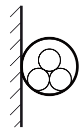
4 To determine the three-phase voltage drop, refer to the appropriate value in Table 46, Table 47 or Table 48. To determine the single-phase voltage drop, multiply the three-phase value by 1.155.

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	19	15	15	13
0.75	24	20	20	16
1.0	28	23	24	19
1.5	37	28	31	24
2.5	50	38	43	32
4	67	50	58	42
6	87	67	74	55
10	120	90	105	76
16	165	119	140	99
25	215	160	185	135
35	265	194	230	163

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.

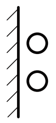
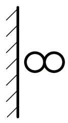
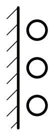
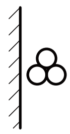
3 These ratings are based on 40°C ambient air temperature. For other conditions, see Clause 3.5.3.

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
Conductor size mm^2	Current-carrying capacity, A					
	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
						
0.6/0.6 kV cables						
1	20	18	16	19	16	15
1.5	26	23	21	25	21	19
2.5	35	31	28	34	28	26
4	47	42	38	45	38	35
1/1 kV cables						
1.5	30	27	24	29	22	22
2.5	40	36	33	39	33	30
4	54	48	43	52	43	40
6	68	62	55	66	55	50
10	93	84	76	90	75	69
16	125	115	100	120	100	92
25	165	150	135	160	135	125
35	205	185	170	200	165	155
50	260	235	210	250	210	190
70	325	295	265	315	265	240
95	380	345	310	365	315	280
120	445	405	360	430	370	330
150	520	470	420	500	430	385
185	610	550	495	590	505	450
240	730	660	590	705	605	540
300	815	735	660	785	690	600
400	1010	915	820	975	855	745

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.

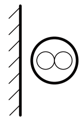
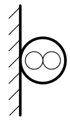
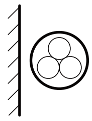
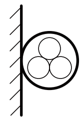
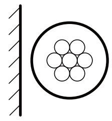
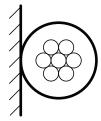
5 These ratings are based on 40°C ambient air temperature. For other conditions, see Clause 3.5.3.

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	18	16	15	14	11	10
1.5	23	21	20	18	15	14
2.5	32	29	27	26	20	19
4	43	40	—	—	—	—
1/1 kV cables						
1.5	27	25	22	21	16	15
2.5	36	33	30	28	22	20
4	48	44	40	38	30	28
6	61	57	51	48	—	—
10	85	78	71	67	—	—
16	115	105	96	90	—	—
25	150	140	125	120	—	—

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.

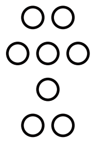
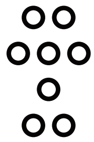
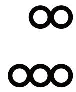
4 For earth sheath return system, temperature rises could be higher. Refer to manufacturer's instructions.

5 These ratings are based on 40°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 (mm^2) 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	37	74	87	—	—	—	—	—	—
6	38	76	89	35	70	79	30	50	59
7/1.25	49	97	115	—	—	—	—	—	—
10	53	105	123	48	96	109	40	68	80
16	71	139	164	65	127	145	52	90	107
7/1.75	76	148	174	—	—	—	—	—	—
7/2.00	89	174	205	—	—	—	—	—	—
25	96	186	220	88	167	191	68	120	142
35	117	226	267	107	203	232	82	145	171
7/2.75	133	257	303	—	—	—	—	—	—
50	142	272	321	130	242	276	97	173	205
19/1.75	142	272	322	—	—	—	—	—	—
19/2.00	168	321	379	—	—	—	—	—	—
70	179	341	403	164	303	347	119	217	257
7/3.50	181	345	407	—	—	—	—	—	—
7/3.75	197	376	444	—	—	—	—	—	—
95	216	410	484	198	360	413	—	—	—
37/1.75	216	410	485	—	—	—	—	—	—
19/2.75	251	474	560	—	—	—	—	—	—
120	255	481	568	234	423	485	—	—	—
19/3.00	280	528	625	—	—	—	—	—	—
150	290	547	646	267	477	546	—	—	—
185	336	628	742	311	543	622	—	—	—
37/2.50	339	634	750	—	—	—	—	—	—

(*continued*)

TABLE 20 (*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**
7/1.00	—	—	—	—	—	—	—	—	—
6	26	48	56	36	56	66	32	54	62
7/1.25	—	—	—	—	—	—	—	—	—
10	36	65	76	48	77	90	44	73	84
16	47	85	100	64	101	119	58	96	111
7/1.75	—	—	—	—	—	—	—	—	—
7/2.00	—	—	—	—	—	—	—	—	—
25	63	113	133	84	135	158	77	127	148
35	76	136	160	—	—	—	—	—	—
7/2.75	—	—	—	—	—	—	—	—	—
50	92	163	192	—	—	—	—	—	—
19/1.75	—	—	—	—	—	—	—	—	—
19/2.00	—	—	—	—	—	—	—	—	—
70	115	204	242	—	—	—	—	—	—
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 40°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 40.

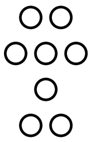
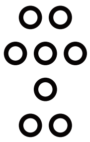
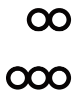
(b) For parallel and webbed cables, see Table 41.

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

4 These ratings are based on 40°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 (mm^2) or standing (No./mm)	Current-carrying, 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	56	109	128	49	97	111	41	71	84
25	76	146	173	67	128	146	53	91	108
35	92	177	209	82	156	178	63	111	132
7/2.50	93	180	213	—	—	—	—	—	—
7/2.75	105	202	239	—	—	—	—	—	—
50	111	214	252	99	186	213	75	134	158
7/3.00	117	225	266	—	—	—	—	—	—
70	141	268	317	126	233	267	92	167	158
7/3.75	156	297	350	—	—	—	—	—	—
95	172	327	386	155	282	323	110	203	243
7/4.50	196	370	438	—	—	—	—	—	—
120	200	378	447	180	326	374	—	—	—
7/4.75	209	395	467	—	—	—	—	—	—
150	228	429	507	206	367	420	—	—	—
19/3.25	244	459	542	—	—	—	—	—	—
185	264	493	583	239	419	479	—	—	—
19/3.50	269	503	595	—	—	—	—	—	—

(*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	36	66	77	49	78	91	44	74	86
25	48	87	101	64	103	121	59	97	113
35	59	105	123	78	125	147	72	118	137
7/2.50	—	—	—	—	—	—	—	—	—
7/2.75	—	—	—	—	—	—	—	—	—
50	71	126	148	94	151	178	88	142	165
7/3.00	—	—	—	—	—	—	—	—	—
70	89	157	185	116	189	223	110	177	207
7/3.75	—	—	—	—	—	—	—	—	—
95	108	191	229	141	231	274	136	216	257
7/4.50	—	—	—	—	—	—	—	—	—
120	—	—	—	—	—	—	157	249	300
7/4.75	—	—	—	—	—	—	—	—	—
150	—	—	—	—	—	—	179	282	343
19/3.25	—	—	—	—	—	—	—	—	—
185	—	—	—	—	—	—	—	—	—
19/3.50	—	—	—	—	—	—	—	—	—

NOTES:

1 The current-carrying capacities are based on an ambient air temperature of 40°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 40°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.

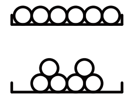
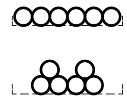
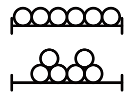
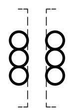
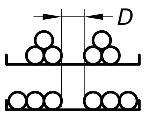
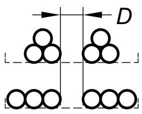
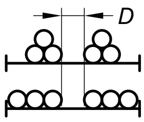
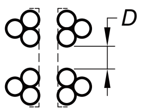
6 No derating factor is applicable for the minimum spacings specified in Clause 3.5.2.2(c) and Figure 1.

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.

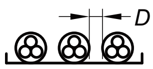
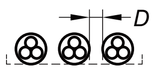
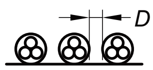
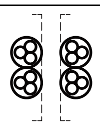
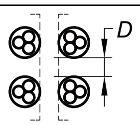
8 No derating factor is applicable for the minimum spacings specified in Clause 3.5.2.2(c) and Figure 1(a).

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	 Touching (see Note 6)	1	0.97	0.85	0.78	0.75	0.71	0.68
2			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		 Spaced (see Note 6)	1	0.97	0.96	0.94	0.93	0.90	—
5			2	0.97	0.95	0.92	0.90	0.86	—
6			3	0.97	0.94	0.91	0.89	0.84	—
7	Perforated trays	 Touching (see Note 6)	1	1.00	0.88	0.82	0.78	0.76	0.73
8			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		 Spaced (see Note 6)	1	1.00	1.00	0.98	0.95	0.91	—
11			2	1.00	0.99	0.96	0.92	0.87	—
12			3	1.00	0.98	0.95	0.91	0.85	—
13	Ladder supports, racks and cleats	 Touching (see Note 6)	1	1.00	0.87	0.82	0.80	0.79	0.78
14			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		 Spaced (see Note 6)	1	1.00	1.00	1.00	1.00	1.00	—
17			2	1.00	0.99	0.98	0.97	0.96	—
18			3	1.00	0.98	0.97	0.96	0.93	—
19	Vertical perforated trays	 Touching (see Note 7)	1	1.00	0.88	0.82	0.77	0.73	0.72
20			2	1.00	0.88	0.81	0.76	0.72	0.70
21		 Spaced (see Note 7)	1	1.00	0.91	0.89	0.88	0.87	—
22			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**

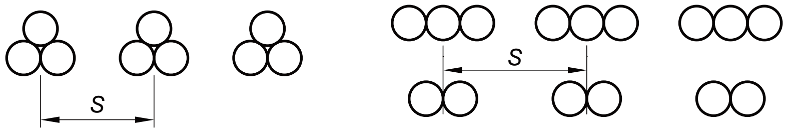
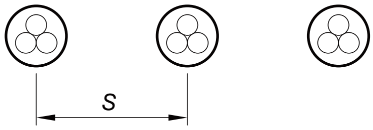
1	2	3	4	5	6	7
Number of circuits						
	Derating factors					
	Touching		**Distance (*S*), m**			
	Trefoil	**Laid flat**	**0.15**	**0.30**	**0.45**	**0.60**
2	0.78	0.81	0.83	0.88	0.91	0.93
3	0.66	0.70	0.73	0.79	0.84	0.87
4	0.61	0.64	0.68	0.74	0.81	0.85
5	0.56	0.60	0.64	0.73	0.79	0.83
6	0.53	0.57	0.61	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**

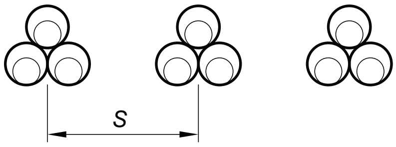
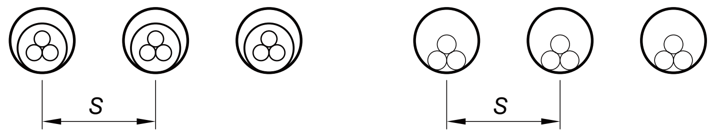
1	2	3	4
Number of circuits			
	Derating factor		
	Touching	**Distance (*S*), m**	
		0.45	**0.60**
2	0.87	0.91	0.93
3	0.78	0.84	0.87
4	0.74	0.81	0.85
5	0.70	0.79	0.83
6	0.69	0.78	0.82
7	0.67	0.76	0.82
8	0.66	0.76	0.81
9	0.65	0.75	0.81
10	0.64	0.75	0.80
11	0.63	0.74	0.80
12	0.63	0.74	0.80

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	1.11	1.09	1.07	1.04	1.02	1.0	0.98	0.95	0.93	0.90	0.88	0.85	0.83	0.80	0.77	0.74	0.69	0.60	0.52	0.43	0.30
110	1.16	1.13	1.10	1.07	1.04	1.0	0.96	0.93	0.89	0.85	0.80	0.76	0.71	0.65	0.60	0.53	0.38	—	—	—	—
90	1.26	1.20	1.15	1.10	1.05	1.0	0.94	0.88	0.81	0.73	0.65	0.57	0.47	0.34	0.19	—	—	—	—	—	—
80	1.31	1.25	1.19	1.12	1.06	1.0	0.92	0.84	0.76	0.66	0.56	0.45	0.27	—	—	—	—	—	—	—	—
75	1.35	1.28	1.21	1.14	1.07	1.0	0.91	0.82	0.72	0.60	0.49	0.37	—	—	—	—	—	—	—	—	—

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 40°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	1.08	1.06	1.03	1.0	0.97	0.94	0.91
90	1.11	1.07	1.03	1.0	0.97	0.93	0.89
80	1.13	1.09	1.04	1.0	0.96	0.91	0.85
75	1.14	1.10	1.05	1.0	0.95	0.89	0.83

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, mm^2		
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 40°C and not 25°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 40°C and not 25°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:

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

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

$$V_p \geq \text{sum of } V_d \text{ on circuit run}$$

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 by $1.155\left(\frac{2}{\sqrt{3}}\right)$.

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—

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

where

V_d = voltage drop in cable, in volts

I = current flowing in cable, in amperes

Z_c = impedance of cable, in ohms

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

where

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:

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

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—

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

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° 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 (IZ_{c}) with the in-phase component of voltage drop in the neutral ($0.5IZ_{\mathrm{c}}$), i.e.—

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

4.3.5 Single-phase, three-wire, earthed centre-tapped 180° 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.—

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

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 (IZ_c) is the same in all cases, but because of the different power factors the voltage (IZ_c) 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 IZ_c 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:

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

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

Therefore, for a single-phase system:

$$V_{d1\phi} = IL\,[2(R_c \cos\theta + X_c \sin\theta)] \qquad \ldots 4.5(3)$$

and a three-phase system:

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

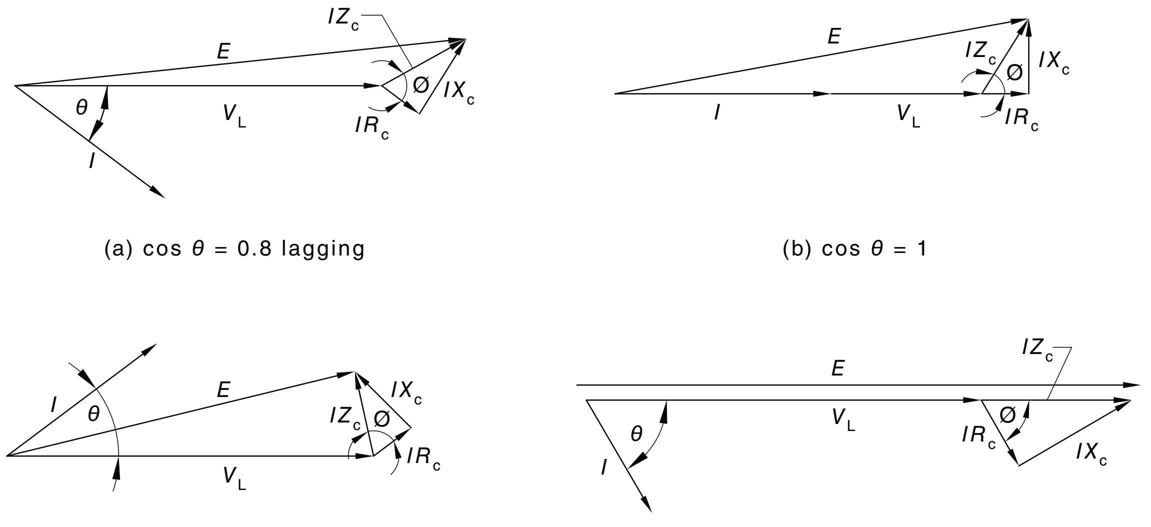
where

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.



(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

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

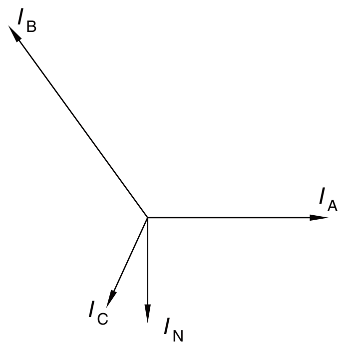
cos θ = power factor of load

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:

$$V_d = \text{voltage drop in heaviest loaded active} + \text{voltage drop in neutral} \qquad \ldots 4.6$$

$$= I_A L_A Z_{cA} + I_N L_N Z_{cN}$$

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.

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

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 Ω/km, 0.0435 Ω/km or 0.0690 Ω/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 $0.5D$, $1D$ or $2D$ separation distances add 0.0254 Ω/km, 0.0435 Ω/km or 0.0690 Ω/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 $5D$ 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				
mm^2	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	0.048	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: 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 5D 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	
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.
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	0.565	0.582	0.582
150	0.422	0.422	0.443	0.443	0.463	0.463	0.468	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 mm² that are spaced up to 5D 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 COMMOM 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	
mm^2	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 mm^2 that are spaced up to 5D 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	10	11
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	
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	2.56	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 mm² that are spaced up to 5D 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	
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	6.96	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 mm^2 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	
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.	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	—	0.270	—	0.280	—	0.290	—	0.297	0.292	0.300	0.295
185	0.228	—	0.236	—	0.243	—	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. 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. 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 (i.e. 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 (i.e. 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 s 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 shall 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:

$$I^2t = K^2S^2 \qquad \ldots 5.3$$

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

Constant (*K*)														
Initial temperature of conductor °C	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 1450 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

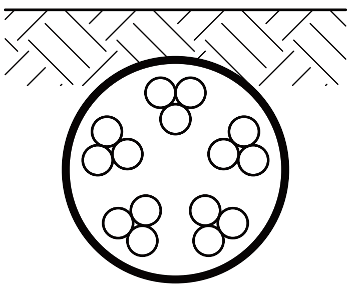
Assuming that the conditions specified in Clause 3.4 apply, i.e. soil ambient temperature, thermal resistivity and depth of laying, the following methods would satisfy the load requirements, if the voltage drop is acceptable:

(a) *Method A—Single conduit or duct* Current-carrying capacity of single 400 mm^2 circuit = 492 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—

$492 \times 5 \times 0.6 = 1476$ A.

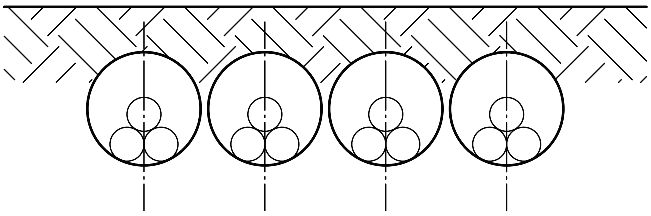


(b) *Method B—Groups of conduits or ducts* Current-carrying capacity of single 400 mm^2 circuit = 492 A (Table 7, Column 24).

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—

$492 \times 4 \times 0.79 = 1554.7$.



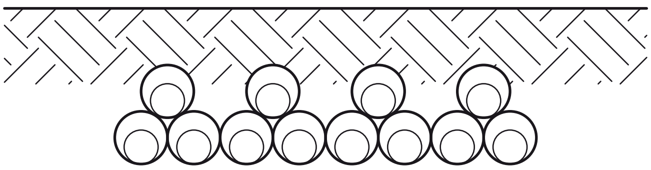
(c) *Method C—Trefoil groups of single-way underground ducts*

Current-carrying capacity of single 400 mm^2 circuit = 553 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—

$553 \times 4 \times 0.74 = 1636.9$ A.

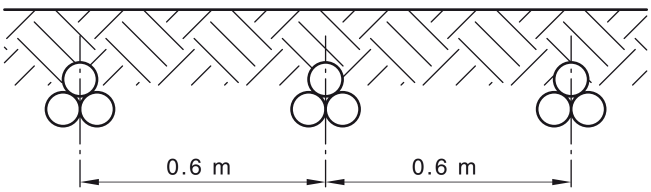


(d) *Method D—Trefoil groups of cable buried direct* Current-carrying capacity of single 400 mm^2 circuit = 593 A (Table 7, Column 22).

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—

$593 \times 3 \times 0.87 = 1547.7$ 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 190 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 28 A while the single-phase value from Table 4 is 32 A.

Using the three-phase approach, $28 \times 0.65 = 18.2$ A.

Using the single-phase approach, $32 \times 0.57 = 18.2$ 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 = 0.82 (Table 27(1), Column 9).

Minimum current-carrying capacity of two parallel cables—

$$125 \times \frac{1}{0.8} \times \frac{1}{0.82} = 190.5 \text{ A; or}$$

95.25 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% (12.45 V) permissible voltage drop in the following equation:

$$L = \frac{1000 \times V_\mathrm{d}}{\mathrm{I} \times V_\mathrm{c}} \qquad \text{. . . A3.2}$$

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:

$$\text{Aluminium}\ \frac{1000 \times 12.45}{62.5 \times 1.36} = 146.5\ \text{m}$$

$$\text{Copper}\ \frac{1000 \times 12.45}{62.5 \times 1.11} = 179.5\,\text{m}$$

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 2.4% (10 V) is permitted for each cable.

A4.2 Solution

The selection of conductor size in this instance shall 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 m	Maximum V_c mV/A.m	Minimum cable size mm²	Maximum current-carrying capacity A	Ratio of actual load current to max. current-carrying capacity of cable
A	40	5.56	10	51	0.88
B	55	4.04	10	51	0.88
C	90	2.47	16	68	0.66
D	135	1.65	25	91	0.49
E	180	1.23	35	112	0.40
F	225	0.98	50	137	0.33

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 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:

Minimum current-carrying capacity required of cables = $45 \times \frac{1}{0.76} = 59.2\text{A}$.

Minimum cable size = 16 mm² (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 mm², 16 mm², 16 mm², 25 mm², 35 mm² and 50 mm² 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 13 are as follows:

Load	Cable size, mm^2			
A	Spaced 6 diameters	Spaced 1 diameter	Touching single layer	Bunched
16	1.5	1.5	2.5	2.5
20	2.5	2.5	4	4
25	2.5	4	4	6
32	4	6	6	10
40	6	6	10	16

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 40°C; or

(b) an ambient air temperature of 25°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 40°C. Equation 4.4(1) may therefore be solved directly for cable operating temperature (θ_0) where the ambient air temperature is 40°C but requires some correction to the rated current (I_R) before application to an ambient air temperature of 25°C. Appropriate calculations are as follows:

(a) *Ambient air temperature 40°C*

$$\left(\frac{55}{72}\right)^2 = \left(\frac{\theta_0 - 40}{75-40}\right) \qquad \text{. . . A6.2(1)}$$

θ_0 = 60.4°C, rounding to 60°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 25°C* The correction factor for operation in a 25°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 = 1.21 [from Table 27(1)]

$$\left(\frac{55}{72\times 1.21}\right)^2=\left(\frac{\theta_0-25}{75-25}\right) \qquad \text{. . . A6.2(2)}$$

θ_0 = 44.9°C, rounding to 45°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. Assuming an ambient air temperature of 40°C and 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 ∠0°A

I_B = 300 ∠120°A

I_C = 230 ∠240°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—

$$V_{dB} = I_B L_B Z_{cB} \qquad \text{. . . A7.2(1)}$$

$$= 300\angle 120^\circ \times 150 \times \frac{0.305}{\sqrt{3}} \times \frac{1}{1000}$$

$$= 7.924\angle 120^\circ V$$

The current flowing in the neutral is determined from the relationship—

$$I_A + I_B + I_C + I_N = 0 \qquad \text{. . . A7.2(2)}$$

$$I_A + I_B + I_C = 195\angle 0^\circ + 300\angle 120^\circ + 230\angle 240^\circ$$

$$= 195 + (-150 + j259.8) + (-115 - j199.2)\text{A}$$

$$= -70 + j60.6$$

$$\therefore I_N = 70 - j60.6$$
$$= 92.6 \angle -40.9°A$$

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.

$$\left(\frac{92.6}{184}\right)^2 = \frac{\theta_0 - 40}{75 - 40} \qquad \text{. . . A7.2(3)}$$

θ_0 = 49°C, say 60°C allowing for contact with conductors operating at higher temperatures

From Table 40 and a conductor temperature of 60°C the three-phase voltage drop is given as 0.563 mV/A.m.

The voltage drop on the neutral conductor alone is therefore—

$$V_{dN} = I_N L_N Z_{cN} \qquad \text{. . . A7.2(4)}$$

$$= 92.6 \angle -40.9 V \times 150 \times \frac{0.563}{\sqrt{3}} \times \frac{1}{1000}$$

$$= 4.515 \angle -40.9°V$$

The maximum single-phase voltage drop is therefore—

$$V_d = V_{dB} - V_{dN} = 7.924 \angle 120° - 4.515 \angle -40.9° \qquad \text{. . . A7.2(5)}$$

$$= -3.962 + j6.863 - 3.413 + j2.956$$

$$= -7.375 + j9.818$$

$$= 12.28 \angle 126.9°V$$

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 must be known.

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.

(ii) 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.

(iii) 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.

(iv) 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-sectional 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 40°C.

Determine the minimum conductor size—

(a) that fulfils the current carrying requirements;

(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 95 mm^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 298A. 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.

$$\left(\frac{160}{298}\right)^2 = \frac{\theta_0 - 40}{90 - 40} \qquad \text{. . . A9.3(1)}$$

θ_0 = 54°C raised to 60°C.

Therefore the a.c. resistance of the 95 mm^2 is 0.225 Ω/km (Table 34, Column 3).

The a.c. resistance for a route length of 100m = 0.225 × 0.1 = 0.0225 Ω.

Step 3 Calculate I^2R loss of the cable

At 80% utility (a current of 160 A), the I^2R loss of the cable is calculated as follows:

$$I^2R = (80\% \times 200)^2 \times 0.0225 = 576 \text{ W per phase or 1728 W for three-phase} \quad \ldots \text{A9.3(2)}$$

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 1728 W is therefore—

$1.728 \times 0.15 \times 24 \times 365 = \$2271.$

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	Earth conductor size*	Upfront cost (3-phase plus earth)†	Current rating‡	Phase conductor temperature	Increase in upfront cost over cost of 95 mm² cable (*cc*)	a.c resistance of phase conductor§	I^2R loss of cable (3-phase)	Cost of I^2R loss	I^2R loss savings (*Y*)
mm²	mm²	$	A	°C	$	Ω	kW	$/year	$/year
95	25	3 511	298	54	—	0.0225	1.728	2 271	—
120	35	4 416	349	51	905	0.0179	1.375	1 806	465
150	50	5 490	403	48	1 979	0.0145	1.114	1 463	808
185	70	6 874	468	46	3 363	0.0117	0.899	1 181	1 090
240	95	8 996	560	44	5 485	0.00862	0.662	870	1 401
300	120	11 260	648	43	7 749	0.00703	0.540	709	1 562
400	120	13 854	756	42	10 343	0.00569	0.437	574	1 697
500	120	17 513	874	42	14 002	0.00467	0.359	471	1 800
630	120	22 278	1010	41	18 767	0.00389	0.299	393	1 878

* Earth size in accordance with AS/NZS 3000:2007, Table 5.1.

† Indicative cost of 4 single core cables, i.e. 3 × 1 C phase and 1 × 1 C 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 net present value of the total cost is the difference between the net present value of savings in the cost of I^2R loss over the time period and the increase in upfront costs.

$$NPV_{\text{total}} = NPV_{\text{savings}} - cc \qquad \text{. . . A9.3(3)}$$

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 \$

$$= \frac{Y(1-(1+r)^{-n})}{r} \qquad \text{. . . A9.3(4)}$$

cc = increase in upfront costs, in \$, i.e. additional cable cost and other associated 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 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 mm^2—

$$NPV_{\text{total}} = \frac{465\left(1-\left(1+0.07\right)^{-20}\right)}{0.07} - 905 = \$4013 \qquad \text{. . . A9.3(5)}$$

NOTE: The way the intermediate results are rounded may influence the NPV_{total}. For example, if the rounded values of 465 and 905 are used NPV_{total} is \$4021. When unrounded numbers are used the NPV_{total} is \$4013.

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 PV_{total} equals zero:

$$NPV_{\text{total}} = NPV_{\text{savings}} - cc$$

$$0 = \frac{Y\left(1-\left(1+r\right)^{-N}\right)}{r} - cc \qquad \text{. . . A9.3(6)}$$

The above can be written as:

$$N = \frac{-\log\left(1-\dfrac{r\times cc}{Y}\right)}{\log\left(1+r\right)} \qquad \text{. . . A9.3(7)}$$

where

N = payback period, in years.

As a result of moving one cable size up to 120 mm^2:

Y = 2271 – 1806 = \$465

cc = 4416 – 3511 = \$905

The payback period (N) in this example is therefore:

$$N = \frac{-\log\left(1-\dfrac{0.07\times 905}{465}\right)}{\log\left(1+0.07\right)} = 2.2 \text{ years} \qquad \text{. . . A9.3(8)}$$

The benefit to cost (B/C) ratio for moving one cable size up to 120 mm^2:

= $\text{NPV}_{\text{total}}/cc$

= 4013/905 = 4.4

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 size 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	year
95	3 511	—	1.728	2 271	—	—	—	—	—
120	4 416	905	1.375	1 806	465	4 918	4 013	2.2	4.4
150	5 490	1 979	1.114	1 463	808	8 553	6 574	2.8	3.3
185	6 874	3 363	0.899	1 120	1 090	11 546	8 183	3.6	2.4
240	8 996	5 485	0.662	870	1 401	14 839	9 354	4.7	1.7
300	11 260	7 749	0.540	709	1 562	16 539	8 790	6.3	1.1
400	13 854	10 343	0.437	574	1 697	17 972	7 629	8.2	0.7
500	17 513	14 002	0.359	471	1 800	19 062	5 060	11.6	0.4
630	22 278	18 767	0.299	393	1 878	19 896	1 129	17.8	0.1

* 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 300 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 $9354 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 35 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 37 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—

$$\frac{35}{0.86} = 41\ \text{A} \qquad \text{. . . C(1)}$$

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—

$$35 \times 0.44 \times 3 = 46.2\ \text{A} \qquad \text{. . . C(2)}$$

and a reduction factor of 0.86 is applied, leading to a design load of—

$$\frac{46.2}{0.86} = 53.7\ \text{A} \qquad \text{. . . C(3)}$$

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—

$$35 \times 0.5 \times 3 = 52.5\ \text{A} \qquad \text{. . . C(4)}$$

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.

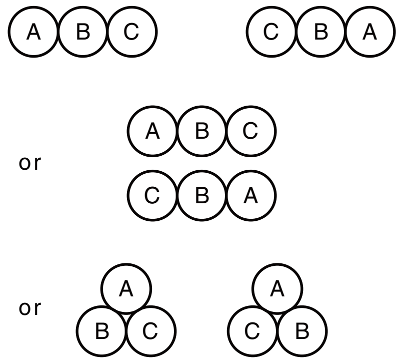
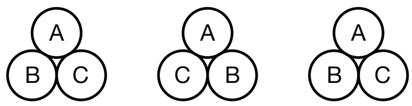
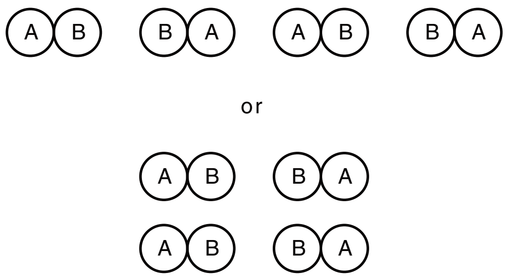
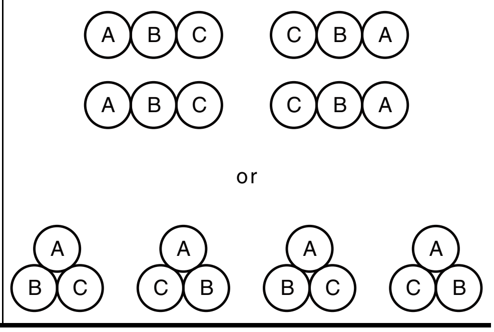
APPENDIX D

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		

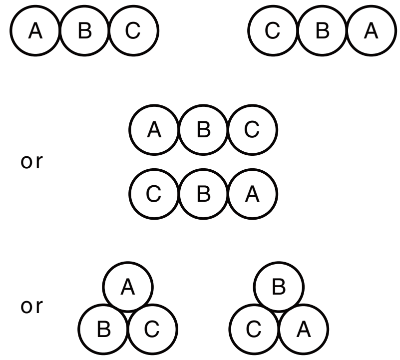
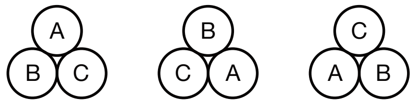
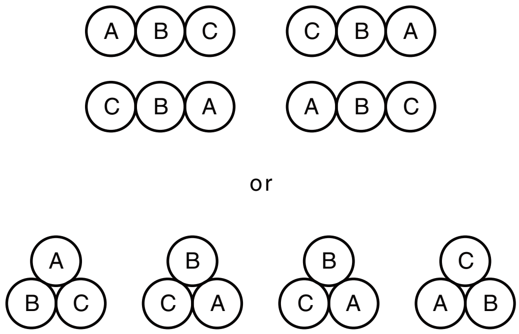
NOTES:

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

Mode	Three-phase
Two conductors per phase	
Three conductors per phase	
Four conductors per phase	

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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