

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



AS/NZS 3008.1.1:2017

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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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STANDARDS AUSTRALIA/STANDARDS NEW ZEALAND

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**

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
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1.4.2 Related documents

Attention is drawn to the following related documents.

AS

- 1531 Conductors—Bare overhead—Aluminium and aluminium alloy
- 1746 Conductors—Bare overhead—Hard-drawn copper
- 3158 Electric cables—Glass fibre insulated—For working voltages up to and including 0.6/1 (1.2) kV

AS/NZS

- 3191 Electric flexible cords
 - 3560 Electric cables—Cross-linked polyethylene insulated—Aerial bundled—For up to and including 0.6/1 (1.2) kV
 - 3560.1 Part 1: Aluminium conductors
 - 3560.2 Part 2: Copper conductors
 - 4026 Electric cables—For underground residential distribution systems
 - 4961 Electric cables—Polymeric insulated—For distribution and service applications
 - 5000 Electric cables—Polymeric insulated
 - 5000.1 Part 1: For working voltages up to and including 0.6/1 (1.2) kV
 - 5000.2 Part 2: For working voltages up to and including 450/750 V
 - 5000.3 Part 3: Multicore control cables
 - 60702 Mineral insulated cables and their terminations with a rated voltage not exceeding 750 V
 - 60702.1 Part 1: Cables
- IEC
- 60724 Short-circuit temperature limits of electric cables with rated voltages of 1.0 kV ($U_m = 1,2$ kV) and 3 kV ($U_m = 3,6$ kV)

INDUSTRY REPORTS

- ICAA Principles of Economic and Energy Efficient Cable Sizing
<http://www.copper.com.au/copper/wcms/en/home/Principles-of-Economic-and-Energy-Efficient-Cable-Sizing.pdf>

1.5 DEFINITIONS

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

1.5.1 Ambient temperature

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

- (a) including any increase in temperature due to materials or equipment to which the cables are connected, or are to be connected; but
- (b) excluding any increase in temperature that may be due to the heat arising from the cables at that point.

1.5.2 Circuit

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

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

1.5.3 Continuous loading

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

1.5.4 Installation wiring

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

NOTE: Replaces the term 'fixed wiring'.

1.5.5 Ladder support

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

1.5.6 Perforated tray

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

1.5.7 Route length

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

SECTION 2 CABLE SELECTION PROCEDURE

2.1 GENERAL

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

2.2 SELECTION PROCESS

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

- (a) *Current-carrying capacity* Dependent upon the method of installation and the presence of external influences, such as thermal insulation, which restrict the operating temperature of the cable.
- (b) *Voltage drop* Dependent upon the impedance of the cable, the magnitude of the load current and the load power factor.
- (c) *Short-circuit temperature limit* Dependent upon energy produced during the short-circuit condition.

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

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

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

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

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

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

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

$$I_B \leq I_Z$$

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

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

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

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

- (i) For a single circuit, determine if the method of installation requires the application of a derating factor selected from 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 ECONOMIC OPTIMIZATION CONSIDERATIONS (OPTIONAL)

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

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

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

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

The initial cost may simply be the present cost of the selected cable, but often includes additional costs, such as labour for installation, termination and additional cable supports etc. The cost of future losses is determined by the sum of the discounted future cost of the losses. Because inflation affects the cost of borrowing money and the cost of energy they cancel each other and therefore 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 elastomeric 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 mm² for aluminium or smaller than 150 mm² for copper: 1 m;
 - (ii) for conductor sizes of 300 mm² or larger for aluminium and 150 mm² 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

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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 derating factors when circuits are bunched.

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

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

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

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

(b) groups of conductors are connected in parallel;

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

3.5.2.8 Cables on drums or reels

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

<i>Number of layers</i>	1	2	3	4
<i>Derating factor</i>	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 laying of 0.5 m as specified in Clauses 3.4.4 and 3.4.5. Where other depths of laying apply, the appropriate rating factors shall be as given in Tables 28(1) and 28(2).

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

3.5.5 Effect of thermal resistivity of soil

The current-carrying capacities given in the tables of this Standard are based on a soil thermal resistivity of $1.2^{\circ}\text{C}\cdot\text{m}/\text{W}$.

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 $0.8^{\circ}\text{C}\cdot\text{m}/\text{W}$. Similarly, values as high as $2.5^{\circ}\text{C}\cdot\text{m}/\text{W}$ may be associated with well drained sands for constantly loaded cables. The value of $1.2^{\circ}\text{C}\cdot\text{m}/\text{W}$ 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 $1.2^{\circ}\text{C}\cdot\text{m}/\text{W}$ 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 $1.2^{\circ}\text{C}\cdot\text{m}/\text{W}$ 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 $1.2^{\circ}\text{C}\cdot\text{m}/\text{W}$:

- (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 $2.7^{\circ}\text{C}\cdot\text{m}/\text{W}$, 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—

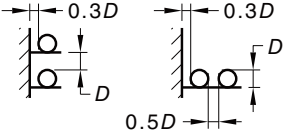
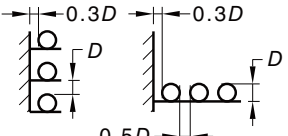
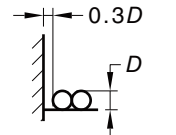
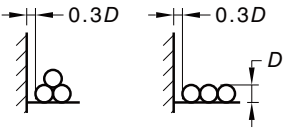
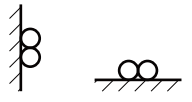
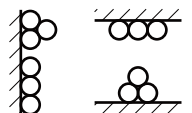
- (a) selection of cables designed for low magnetic field emissions; or

- (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.

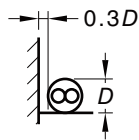
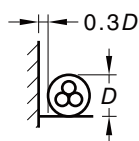
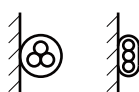
TABLE 3(1)

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;	
3				(b) supported on ladders, racks, perforated trays, cleats or hanger; or (c) suspended from a catenary wire.	
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;	
6				(c) in a switchboard or similar enclosure; or (d) supported from a catenary wire.	
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;	22
8	Three single-core cables		Tables 7 and 8 (see Note 4) Columns 8 to 10 Table 9 Columns 6 and 7.	(b) in a ventilated trench or open trunking; (c) buried directly in a plaster or render on a wall; or (d) in a switchboard or similar enclosure.	

(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.

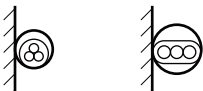
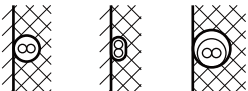
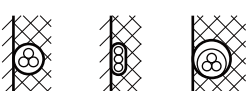
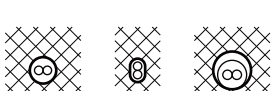
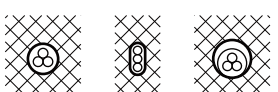
TABLE 3(2)

**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)

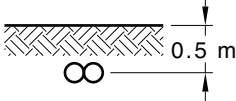
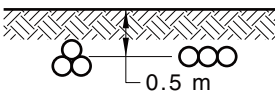
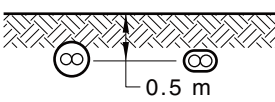
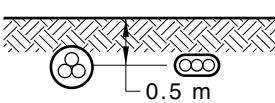
1	2	3	4	5	6
Item No.	Cable details (see Note 1)	Reference drawing (see Note 2)	Current-carrying capacity table reference	Methods of installation for cables deemed to have the same current-carrying capacity (see Note 3)	Derating table
7	Two-core cables		Tables 10 and 11 Columns 11 to 13 Table 12 Columns 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**

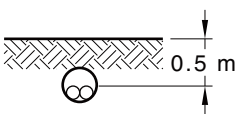
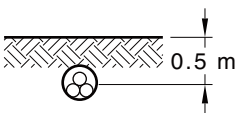
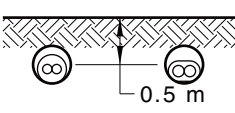
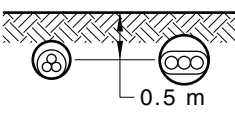
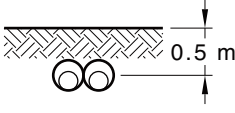
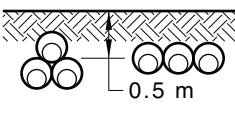
1	2	3	4	5	6
Item No.	Cable details (see Note 1)	Reference drawing (see Note 2)	Current-carrying capacity table reference	Methods of installation for cables deemed to have the same current-carrying capacity (see Note 3)	Derating table
1	Two single-core cables		Tables 4 and 5 Columns 22 and 23 Table 6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

NOTES:

- 1 Earthing conductors, lightly loaded neutral conductors of three-phase circuits and conductors subject only to momentary loading, such as control wiring, shall not be counted in the number of cable cores.
- 2 See column headings of Tables 4 to 15.
- 3 See Tables 27(1), 27(2), 28(1) and 28(2) for rating factors applicable to different ambient soil temperatures and depths of laying.

TABLE 3(4)

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

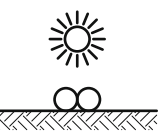
1	2	3	4	5	6	
Item No.	Cable details (see Note 1)	Reference drawing (see Note 2)	Current-carrying capacity table reference	Methods of installation for cables deemed to have the same current-carrying capacity (see Note 3)	Derating table	
					More than one circuit in same enclosure	More than one circuit 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.

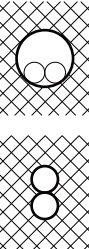
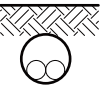
TABLE 4
CURRENT-CARRYING CAPACITIES

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
	Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible	
mm ²												
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)

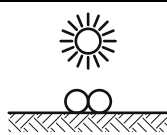
14	15	16	17	18	19	20	21	22	23	24	25	26	27	28
Conductor size	Current-carrying capacity, A													
	Enclosed			Thermal insulation				Buried direct		Underground wiring enclosure				
	Wiring enclosure in air			Partially surrounded by thermal insulation		Completely surrounded by thermal insulation								
														
	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 mm² 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 mm²) 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.

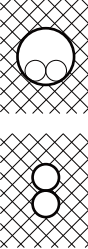
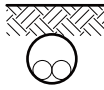
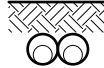
TABLE 5
CURRENT-CARRYING CAPACITIES

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
	Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible		Solid/ Stranded	Flexible	
mm²												
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
mm ²	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 mm² 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 mm² 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

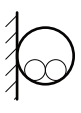
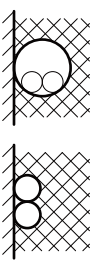
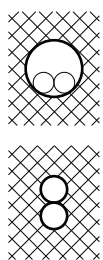
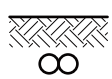
MAXIMUM CONDUCTOR TEMPERATURE: 110°C

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	
	Solid/ Stranded	Flexible	Solid/ Stranded	Flexible	Solid/ Stranded	Flexible	Solid/ Stranded	Flexible
mm ²								
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 mm² in Column 15, the values are based on ratings for wiring in underground wiring enclosures.