TABLE 3.2

LIMITING TEMPERATURES FOR INSULATED CABLES

Type of cable insulation[1]	Operating temperature of conductor, °C		
	Normal use[2]	Maximum permissible[7]	Minimum ambient[3]
Thermoplastic[4]			
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
Elastomeric			
R-EP-90	90	90	−40
R-CPE-90, R-HF-90, R-CSP-90	90	90	−20
R-HF-110, R-E-110	110	110	*
R-S-150	150	150	−50
Cross-linked polyethylene			
X-90, X-90UV, X-HF-90	90	90	*
X-HF-110	110	110	*
MIMS[5]	100	250	[6]
Other types			
PE, LLDPE	70	70	*

* Refer to manufacturer's information.

NOTES:

1 The types of cable insulation given in Table 3.2 are included in relevant specifications, i.e. the AS/NZS 5000 series, AS/NZS 3191, AS/NZS 3808 and AS/NZS 60702.1.

2 Lower maximum temperatures will apply where materials used in the construction of the cables or in association therewith, such as coverings, sheathings, insulating sleeving on connections and sealing compounds, have maximum operating temperatures lower than the cable proper. However, the allowable operating temperatures for such materials shall not be exceeded.

3 If manufacturer's recommendations permit, cables may be installed in locations where temperatures lower than specified may occur.

4 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 because of the risk of thermal deformation of insulation if the cables are clipped, fixed or otherwise installed in a manner that exposes cable to severe mechanical pressure at higher temperatures.

V-90 and V-90HT insulated cables may be operated up to the maximum permissible temperatures of 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 damage for temperatures higher than 75°C. Such applications also allow for cables to be installed in—

(a) locations where the ambient temperature exceeds 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.

5 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, dependent on 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.

6 The minimum ambient temperature of use for MIMS cables depends on the cable seal used and manufacturer's recommendations should be followed.

7 Current-carrying capacities determined in accordance with the AS/NZS 3008.1 series do not take into account the effect of temperature rise on the terminals of electrical equipment that can result in the temperature limits of the insulation of cables in the vicinity of the terminals exceeding the limits specified in Table 3.2. In such cases reference should be made to warnings given in the electrical equipment Standards.

3.4.3 Conductors in parallel

Current-carrying capacities for circuits comprising parallel multi-core cables or groups of single-core cables may be determined from the sum of the current-carrying capacity of the various cables connected in parallel provided that the following requirements are met:

(a) Cables shall be not less than 4 mm^2.

(b) Grouping of cables shall not affect the cooling of each parallel cable, or group, by the ambient air or the ground.

(c) The load current sharing between each parallel cable or group shall be sufficient to prevent overheating of any cable or group.

Example:

Equal load current sharing may be achieved by the selection and installation of cables to give the same impedance for each cable in the group. This condition is satisfied when—

(i) conductors are of the same material and cross-sectional area with a minimum size of 4 mm^2;

(ii) cables follow the same route and achieve the same length;

(iii) conductors of each parallel cable, or group, are effectively joined together at each end; and

(iv) the relative position of phase and neutral conductors in and between parallel groups takes account of mutual impedance.

Exception: Unequal load current sharing between cables or groups may be permitted, in accordance with Part 1 of this Standard, 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.

NOTE: The AS/NZS 3008.1 series provides recommended circuit configurations for the installation of parallel single-core cables in electrically symmetrical groups. The recommended method is to use trefoil groups containing each of the three phase conductors and neutral in each group.

3.4.4 Coordination between conductors and protective devices

In accordance with Clause 2.5.3, the continuous current-carrying capacity of the cables shall be coordinated with the current for which the circuit is designed and the type and current rating of the overload protective device.

Taking into account the different overload operating characteristics for fuses and circuit-breakers, one of the relevant following conditions shall be satisfied:

(a) The current rating of circuit-breakers shall not be greater than the cable current-carrying capacity ($I_B \leq I_N \leq I_Z$; see Clause 2.5.3.1).

(b) The current rating of HRC fuses shall not be greater than 90% of the cable current-carrying capacity ($I_B \leq I_N \leq 0.9\ I_Z$; see Clause 2.5.3.1).

3.5 CONDUCTOR SIZE

3.5.1 General

The nominal cross-sectional area of conductors shall be not less than the values given in Table 3.3.

TABLE 3.3

NOMINAL MINIMUM CROSS-SECTIONAL AREA OF CONDUCTORS

Type of wiring system	Use of the circuit	Conductor	
		Material	Cross-sectional area mm^2
Insulated conductors	Socket-outlets (see *Exception 1*)	Copper	2.5
	Other circuits		1
	Signal and relay control circuits		0.5
Bare conductors	—	Copper	6
Insulated flexible conductors	—	Copper	0.75
Aerial wiring	—	Copper	6
		Aluminium	16

Exceptions:

1 *Smaller conductors may be used on subcircuits supplying socket-outlets, based on their suitability, in accordance with this Standard, and taking account of voltage drop, current-carrying capacity and reliability of connections.*

2 *Table 3.3 does not limit cable sizes for extra-low voltage or switchboard wiring.*

NOTE: The size of unprotected consumer mains should be coordinated with the electricity distributor.

3.5.2 Neutral conductor

The minimum size of the neutral conductor shall be as follows:

(a) *Single-phase two-wire circuit* The neutral conductor or conductors of a single-phase consumer main, submain or final subcircuit shall have a current-carrying capacity not less than—

(i) the current-carrying capacity of the associated active conductor; or

(ii) the total current to be carried, where there is more than one active conductor.

(b) *Multiphase circuit* The current-carrying capacity of the neutral conductor of a multiphase circuit shall not be less than that determined in accordance with the following:

(i) *Harmonic currents* Where a consumer main, submain or final subcircuit supplies a substantial load that generates harmonic currents, e.g. fluorescent lighting, computers, soft starters, variable speed devices or other electronic devices, the third and any higher order harmonic current generated in the equipment

shall be added to the maximum out-of-balance load to determine the current to be carried by the neutral conductor.

For this purpose the third and any higher order harmonic current in the neutral conductor shall be taken as 100% of the highest load-generating harmonic currents on any phase.

NOTES:

1 A harmonic current load that constitutes not less than 40% of the total load on any single-phase is regarded as substantial.

2 The third harmonic currents (and odd multiples thereof) are additive to the normal 50 Hz current to be carried. Therefore, it may be necessary for the capacity of a neutral conductor to be greater than that of the associated active conductors. Further information can be obtained from a number of sources including IEC 60364-5-52.

(ii) *Consumer mains, submains and final subcircuits* The current-carrying capacity of the neutral conductor of multiphase consumer mains, submains or final subcircuit shall be not less than that of the current-carrying capacity of the largest associated active conductor.

NOTE: Where more than one active conductor is connected to the one phase, the associated active conductor, for the purposes of this Clause, is the sum of the cross-sectional areas of all conductors connected to any one phase, e.g. conductors connected in parallel or separately metered portions of consumer mains operating on the same phase.

Exceptions:

1 Out-of-balance currents that may arise from the operation of protective devices and other similar abnormal conditions need not be considered.

2 The neutral conductor of a multiphase circuit may have a current-carrying capacity lower than that determined by this Clause, provided that a detection device is fitted and arranged so that the neutral current cannot exceed the current-carrying capacity of the neutral conductor.

3 The neutral conductor of a multiphase circuit may have a current-carrying capacity less than that of the largest associated active conductor, provided that the predominant load consists of multiphase equipment and the current-carrying capacity is not less than the maximum out-of-balance current, including any harmonic component.

(c) *PEN conductors* The minimum size of a combined protective earth and neutral (PEN) conductor of consumer mains, or of a submain to an outbuilding of an electrical installation forming a separate MEN installation in accordance with Clause 5.5.3.1, shall—

(i) comply with the requirements of Item (a) or Item (b), as appropriate; and

(ii) be not less than that of an earthing conductor as required by Clause 5.3.3.

3.5.3 Earthing conductor

The size of an earthing conductor shall be determined in accordance with Clause 5.3.3.

3.6 VOLTAGE DROP

3.6.1 General

Under normal service conditions, the voltage at the terminals of any power-consuming electrical equipment shall be not less than the lower limit specified in the relevant electrical equipment Standard.

Where the electrical equipment concerned is not covered by a Standard, the voltage at the terminals shall be such as not to impair the safe functioning of the electrical equipment.

3.6.2 Value

The cross-sectional area of every current-carrying conductor shall be such that the voltage drop between the point of supply for the low voltage electrical installation and any point in that electrical installation does not exceed 5% of the nominal voltage at the point of supply.

The value of current used for the calculation of voltage drop on a circuit need not exceed the—

(a) total of the connected load supplied through the circuit;

(b) maximum demand of the circuit; or

(c) current rating of the circuit protective device.

NOTES:

1 Motor-starting, solenoid-closing and other similar applications which may cause high transient currents, causing an increased transient voltage drop are excluded from consideration.

2 A simplified method of estimating voltage drop is provided in Appendix C. Detailed information on choosing conductor sizes, taking into account voltage drop, is given in the AS/NZS 3008.1 series.

* 3 For voltage rise (reverse voltage drop) in grid connected inverters, refer to AS/NZS 4777.1.

Conductors with green, yellow or green/yellow combination coloured insulation or sheathing shall not be used as active or neutral conductors in installation wiring. In New Zealand, use of these colours is restricted for conductors but not for sheathing. NZ

Exception: The colour identification provisions of Table 3.4 need not apply to the special applications listed in Clause 3.8.3.

* In New Zealand, there is no restriction on sheathing colour. NZ

NOTES:

1 Internal wiring of equipment is not regarded as installation wiring but may be subject to particular equipment standards.

* 2 Switchboard wiring is not regarded as installation wiring but the AS/NZS 3439 series and AS/NZS 61439 series restrict the green/yellow combination to the identification of earthing conductors.

TABLE 3.4

CONDUCTOR COLOURS FOR INSTALLATION WIRING

Function	Insulation colour
Protective earth	Green/yellow
Equipotential bonding	Green/yellow
Neutral	Black or light blue
Active	Any colour other than green, yellow, green/yellow, black or light blue

NOTES:

1 When green/yellow is used, one colour shall cover not less than 30% and not more than 70% of the surface area, with the other colour covering the remainder of the surface.

2 Recommended colours for actives are—

(a) Red or brown for single-phase; or

(b) Red, white or blue for multiphase.

3 Where colours are used for the identification of cable cores, Australian and New Zealand cable identification colours and European cable identification colours shall not be combined within the same wiring enclosure or the same multi-core cable.

* 4 In New Zealand domestic installations, the only permitted colour for neutral conductors is black. NZ

3.8.2 Colour identification

1 *Colour identification by sleeving or other means*

Colour identification by sleeving or other means, using colours corresponding to those listed in Table 3.4 at each termination, may be used as a means of identification for the following purposes:

(a) Conductors with black or light blue insulation used as active conductors.

3.12 AERIAL WIRING SYSTEMS

NOTE: The use of aerial wiring systems may be prohibited by the relevant regulatory authority in some areas, particularly those areas at risk of bushfire.

3.12.1 Types of conductor

Conductors used as aerial conductors shall be—

(a) hard-drawn bare conductors;

(b) polymeric insulated cables;

(c) neutral-screened cables; or

(d) parallel-webbed, twisted or bundled insulated cables.

3.12.2 Arrangements

3.12.2.1 *Insulation of aerial conductors*

Aerial conductors shall be insulated in the following situations:

(a) For any conductor span that is attached to a building or structure.

Exception: This requirement need not apply to aerial conductors between and supported by two independent poles or similar independent supports.

(b) For any conductor span within arm's reach of any building, building opening or structure.

(c) Above areas where sailing craft or irrigation pipes are used (see Table 3.8).

(d) In areas declared by the responsible fire authority as being subject to bushfires, where required by the regulatory authority or the electricity distributor.

3.12.2.2 *Minimum size*

The minimum size of aerial conductors shall be as follows:

(a) *Copper and aluminium conductors* Copper or aluminium conductors installed as aerial conductors shall have not less than seven strands and shall be not smaller than 6 mm^2 for copper or 16 mm^2 for aluminium.

(b) *Steel conductors* Steel conductors installed as aerial conductors shall have not less than three strands.

3.12.3 Clearances

3.12.3.1 *General*

Aerial conductors for low voltage systems shall be installed such that clearances from ground, buildings and structures other than public roadways are not less than those given in Table 3.8.

NOTE: These clearances do not apply to pole supports or independent supports for the aerial conductors themselves.

Clearances shall be maintained in any direction from any position to which any part of such conductors may either sag at a maximum conductor temperature of 115°C or move as a result of wind pressure.

When aerial conductors are being strung, an additional clearance shall be provided so that the distances specified in Table 3.8 are obtained up to a maximum conductor temperature of 115°C.

NOTE: Table D2 of Appendix D uses sag allowances that make provision for additional clearances.

Where aerial conductors terminate above or to the side of a building or structure, a suitable clearance to prevent contact with the building or structure shall be provided.

Connections between aerial conductors and circuit wiring shall not be regarded as aerial conductors but shall be out of arm's reach from the ground or from an elevated area.

NOTE: Regulatory authorities may have additional requirements regarding aerial conductor clearances.

3.12.3.2 *Safety warnings*

Suitable devices or notices, warning of the presence of aerial conductors, shall be erected in locations where such conductors are erected—

(a) above areas used by sailing craft;

(b) where long lengths of conductive piping, such as irrigation pipes, may reasonably be expected to be raised or otherwise handled;

(c) where loading or unloading of high vehicles is likely to occur; or

(d) in other locations where the risk of inadvertent contact with aerial conductors may reasonably be anticipated.

NOTES:

1 The responsible water authority may have additional signage requirements where aerial conductors cross a waterway.

2 The relevant authority may require aerial conductors in the vicinity of an aerodrome, airport or landing strip to carry aircraft warning devices.

TABLE 3.8

MINIMUM AERIAL CONDUCTOR CLEARANCES

All dimensions in metres

Type of aerial conductor	Minimum height above buildings, structures, ground or elevated areas				From buildings—Horizontal clearance from walls, etc.	From clothes lines, radio and television aerials, counter-poise or stay wires	From tele-communications lines[2]	Above swimming pools	Above areas where sailing craft, or irrigation pipes are used[3]
	Over areas used by vehicles	Over areas not used by vehicles	Over roofs used for traffic or resort	Over other roofs and structures					
Bare live conductors	5.5	5.0	3.7	3.0	2.0	2.0	1.2	Not permitted	Not permitted
Insulated and unsheathed live conductors	4.6	3.0	3.0	2.0	1.0	2.0	0.6	3.0	5.5
Neutral-screened cable	4.6	3.0	2.7	0.5	1.0	2.0	0.6	3.0	4.5

NOTES:

1 When erecting aerial conductors an allowance for sag and sway under operating conditions needs to be added to ensure that the above clearances are maintained. (Refer Clause 3.12.3 and Appendix D.)

2 Further information regarding required clearances for crossing telecommunication lines is contained in AS/CA S009.

3 Warning notices shall be erected where required by Clause 3.12.3.2.

4 Increased distances may be required over public roadways.

NOTES:

1 Guidance on materials suitable for restoring fire-rated constructions is given in national building codes.

2 National building codes may have requirements for restoring acoustic insulation that has been penetrated by electrical equipment.

4.2.2.7 *Thermal insulation—New Zealand only* NZ

In New Zealand only, appliances and accessories in domestic installations shall be installed on the assumption that thermal insulation in ceilings, walls and under floors, if not currently installed, will be installed in the future.

4.2.3 Protection against burns

An accessible part of electrical equipment within arm's reach shall not attain a temperature in excess of the appropriate limit stated in Table 4.1.

Each accessible part of the electrical installation that may, even for a short period, attain a temperature exceeding the appropriate limit in Table 4.1 under normal load conditions shall be guarded so as to prevent accidental contact.

Exceptions:

1 This requirement need not apply to electrical equipment that complies with a limiting temperature specified in an appropriate Standard.

2 This requirement does not apply to items such as lamps.

TABLE 4.1

TEMPERATURE LIMITS IN NORMAL SERVICE FOR PARTS OF ELECTRICAL EQUIPMENT WITHIN ARM'S REACH

Accessible part	Material of accessible surface	Maximum temperature °C
Hand-held means of operation	Metallic	55
	Non-metallic	65
Parts intended to be touched but not hand-held	Metallic	70
	Non-metallic	80
Parts that need not be touched for normal operation	Metallic	80
	Non-metallic	90

4.3 CONNECTION OF ELECTRICAL EQUIPMENT

4.3.1 General

Electrical equipment may be connected to the installation wiring by one of the methods detailed in Clauses 4.3.2 to 4.3.5.