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NZECP 28:1993

NEW ZEALAND ELECTRICAL CODE OF PRACTICE

for

SELECTION AND INSTALLATION OF CABLES

Issued by the Office of
The Chief Electrical Inspector,
Energy and Resources Division, Ministry of Commerce

THE ELECTRICITY ACT 1992

APPROVAL OF ELECTRICAL CODE OF PRACTICE

FOR

SELECTION AND INSTALLATION OF CABLES

Pursuant to Section 36 of the Electricity Act 1992 ("the Act")

On the 1st day of February 1993, the Secretary of Commerce issued the Electrical Code of Practice for Selection and Installation of Cables ("the Code")

On the 4th day of February 1993, pursuant to Section 38 of the Act the Secretary published in the Gazette a notice of intention to apply to me for approval of the code, and there has been consultations with such persons (or their representatives) as will be affected by the Code and they have had the opportunity to consider possible effects and comment on those effects.

I have considered the comments concerning those effects and where necessary amendments were made to the Code.

Therefore Pursuant to Section 38 of the Act, I, John Luxton, Minister of Energy, have this day approved the Code as attached to this approval, which Code shall come into force on the 1st day of April 1993.

Dated this 18th day of March 1993.

John Luxton
Minister of Energy.

COMMITTEE REPRESENTATION

This Code of Practice was prepared by the Ministry of Commerce, Chief Electrical Inspector's Office with reference to the following organisations:

Electrical Contractors' Association of NZ Inc.
Electrical Supply Engineers' Association of NZ Inc.
New Zealand Electrical Institute
Electrical Inspectors' Association
Institution of Professional Engineers of New Zealand

ACKNOWLEDGEMENT

The source material for this Code was derived from the following documentation, Australian Standards AS 3000, and AS 3008.

REVIEW

This Code of Practice will be revised as occasions arise. Suggestions for improvement of this Code are welcome. They should be sent to the Chief Electrical Inspector's Office, Ministry of Commerce, P O Box 1473, WELLINGTON.

CONTENTS

INTRODUCTION

The current carrying capacity of electrical cables is determined by international experience and experimentation. Each country using this current rating then alters the figures to suit local building techniques, climate conditions and installation practices. The previous current ratings, which formed part of the 1976 Handbook were adapted from those used in the United Kingdom.

As a result of the ongoing alignment with Australia the New Zealand cable ratings have been revised and aligned with those in Australia where comparable conditions and practices apply.

While the majority of cable rating information is contained within AS 3008 the ratings of the more commonly used cables are contained in this Code.

This Code also generally aligns the other requirements applying to the selection and installation of cables.

SECTION 1

SCOPE, ALTERNATIVE SPECIFICATIONS, REFERENCED DOCUMENTS, INTERPRETATIONS, GLOSSARY AND NUMBERING

1.1 SCOPE

1.1.1 This Code sets out methods for the selection and installation of electrical cables for fixed wiring.

1.1.2 This Code sets minimum obligations and the following matters are subject to further obligations elsewhere see clause 1.1.3 below:

(a) The installation of Mineral Insulated Metal-Sheathed (MIMS) Cables;
(b) Cables installed in hazardous areas;
(c) Wiring and fittings which are used for any purposes other than the consumption of electricity in relation to premises owned or occupied by an electricity retailer or electricity operator;
(d) Equipment belonging to the electricity retailer or electricity operator in consumers premises;
(e) Wiring inside appliances;
(f) Telecommunication Network Voltage installations.

1.1.3 There are further obligations in respect of these matters in clause 1.1.2 above, e.g. New Zealand Electrical Code of Practice for Electrical Installations of Mineral Insulated Cables and Equipment 1993 (NZECP:33 1993) applies to (a), there are regulatory requirements additional to this Code which apply to (b), (c), (d), (e) and (f).

1.2 ALTERNATIVE SPECIFICATIONS

Where the type of cable or method of installation is not specifically covered in the tables of this Code, current-carrying capacities can be obtained from AS 3008.1.

1.3 REFERENCED DOCUMENTS

AS 1939 Classification of degrees of protection provided by enclosures for electrical equipment.

AS 3008.1 Cables for alternating voltages up to and including 0.6/1 kV.

1.4 INTERPRETATIONS

In this Code, unless the context otherwise requires:

1.4.1 Fittings - means all machines and appliances in which conductors are used.

1.4.2 Phase conductor - means any conductor having a difference of potential from the neutral or earth conductor or ground.

1.4.3 Ambient temperature - means the temperature of the medium in the immediate neighbourhood of the installed cable:

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

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

1.4.4 Cable - means a length of insulated single conductor (solid or stranded), or two or more such conductors, each provided with its own insulation, which are laid up together, which insulated conductor or conductors may or may not be provided with an overall mechanical protective covering.

1.4.5 Circuit - means an arrangement of conductors for the purpose of carrying current.

1.4.6 Circuit-breaker - means a protective device suitable for opening a circuit automatically, as a result of short circuit or overload.

1.4.7 Conductor - means a conductor or other form of conducting material suitable for carrying current, but not including wire or other metallic parts directly employed in converting electrical energy into another form.

1.4.8 Flexible cable - means a cable, the conductors, insulation and covering of which are such as to afford flexibility.

1.4.9 Fixed wiring - means a system of wiring in which cables are fixed or supported in position.

1.4.10 Open wiring - means a system of wiring in which unsheathed cables are installed without further protection.

1.4.11 Route length - means the distance measured along a run of wiring from the origin of the circuit to a point. (e.g the distance measured between a switchboard and a motor).

1.4.12 Telecommunication network voltage - means a circuit that under normal conditions carries telecommunication signals and has separation from circuits at hazardous voltage such that, under single fault conditions, the circuit voltage does not exceed the limits laid down in standards for safety of telecommunication apparatus.

1.5 GLOSSARY OF ABBREVIATIONS USED IN THIS CODE

a.c.	Alternating current
AS	Australian Standard
C	Celsius
ELV	Extra Low Voltage
IP	Ingress protection code
kV	Kilo-volts (1000 volts)
m	Metres
MIMS	Mineral insulated metal sheathed cable
mm	Millimetres
mm^2	Square millimetres
NZECP	New Zealand Electrical Code of Practice
NZS	New Zealand Standard
PVC	Poly vinyl chloride
TNV	Telecommunication Network Voltage
UV/PVC	Ultra-violet stabilised poly vinyl chloride

1.6 NUMBERING SYSTEM OF THIS CODE

1.6.1 Sections are numbered from 1 to 5.

1.6.2 Subsections are numbered by one full stop between two numbers. (eg: 1.6)

1.6.3 Clauses are numbered by two full stops between three numbers. (eg: 4.18.3)

1.6.4 Subclauses are numbered by three full stops between four numbers. (eg: 3.2.1.1)

1.6.5 Paragraphs contain numbering punctuated by one or more full stops together with a parenthesised letter.

1.6.6 Subparagraphs are represented by lower case roman numerals enclosed in parenthesis following paragraphs.

SECTION 2

CABLE/CONDUCTOR REQUIREMENTS

2.1 GENERAL

2.1.1 All cables shall have adequate strength and be so installed as to withstand the electromechanical forces that may be caused by any current they may have to carry in service, including short circuit current.

2.1.2 Every cable shall be so selected and installed as to be suitable for operation under such ambient temperatures as are likely to occur.

2.1.3 The maximum current in any bare conductor or cable conductor shall not exceed the current rating of that conductor or cable for the conditions in which the conductors or cables are used.

2.1.4 The cross sectional area of every cable conductor shall be such that its current carrying capacity is not less than the maximum sustained current which will normally flow through it.

2.1.5 The size of every cable or bare conductor shall be such that the voltage drop within the installation does not exceed a value appropriate to the safe functioning of the associated equipment in normal service.

2.1.5.1 Unless an installation is specifically designed to take account of voltage drop, the wiring to all low voltage supplies shall ensure that the drop in voltage shall not exceed 2.5% of the standard voltage.

2.2 MINIMUM CONDUCTOR SIZE

2.2.1 The minimum size of conductors shall be 1 mm^2, unless otherwise specified in this Code.

2.2.1.1 No minimum size need apply for signal and relay control circuits when installed within switchboards and control panels.

2.2.2 The cross sectional area of any aluminium conductor shall be no less than:

(a) 2.5 mm^2 for multicore cables with solid conductors.
(b) 6 mm^2 for solid conductors other than cores of multicore cables.
(c) 16 mm^2 for cables with stranded conductors.

2.3 CABLE IDENTIFICATION

Fixed wiring conductors.

2.3.1 Conductors of cables used for fixed wiring shall be identified by either:

(a) The colour of the insulation or covering; or

(b) The colour of the insulating-sleeve fitted on the dielectric or on the conductor where it emerges from the dielectric; or

(c) A system of numbers where this is the valid method for a cable.

2.3.2 Where colours are used for identification of fixed wiring conductors, the following shall be employed for conductors other than earthing conductors:

Conductors	**Colour**
Neutral conductor single phase a.c.	Black
Neutral conductor three phase a.c.	Black
Middle earthed conductor single phase a.c. three wire system	Black
Middle or earthed conductor direct current three wire system	Black
Negative conductor direct current two wire system	Black or Blue
Phase conductor single phase a.c.	Any colour except Black, Green, or Green and Yellow in combination
Phase conductor three phase a.c.	Any colour except Black, Green, or Green and Yellow in combination
Outer conductors single phase a.c. three wire system	Any colour except Black, Green, or Green and Yellow in combination
Active conductor direct current two wire system	Any colour except Black, Blue, Green, or Green and Yellow in combination

Earthing conductors.

2.3.3 Only earthing conductors shall be identified by the colour:

(a) Green; or

(b) A combination of Green and Yellow.

2.3.3.1 Where a combination of Green and Yellow is used, any one of the two colours shall cover not less than 30 percent of the surface area of any 15 mm length of conductor.

2.3.3.2 For paper-insulated cable, the earthing conductor need not be identified throughout its entire length provided that it is covered at the terminations by sleeving coloured Green, or Green and Yellow in accordance with clause 2.3.3 and subclause 2.3.3.1.

2.3.4 Equipotential bonding conductors shall be identified in the same manner as provided for an earthing conductor.

Conductors of flexible cords.

2.3.5 The live conductors of flexible cords shall be coloured with any colour other than green or green and yellow in combination, and shall be identifiable throughout their length by the colour of the insulation or covering of the conductors as follows:

(a) For single phase two core and three-core flexible cords:

Conductors	**Colour**
Phase conductor	Brown
Neutral conductor	Blue
Earthing conductor	Green/Yellow

(b) For flexible cords other than those specified in paragraph (a) of this clause, live conductors may be of any colour, provided that the colours Green or Green and Yellow in combination shall be used only for earthing conductors and provided further that no other colour shall be used as the earthing conductor.

2.3.5.1 Where a combination of Green and Yellow is used for the earthing conductor, any one of the two colours shall cover not less than 30 percent of the surface area of any 15 mm length of conductor.

SECTION 3

SELECTION PROCESS

3.1 GENERAL

3.1.1 The type and current carrying capacity of every conductor, cable, flexible cord, termination and joint shall be selected so as to be suitable for the highest temperature likely to occur in normal service. Account shall be taken of any transfer of heat from any accessory, appliance or luminaire to which the conductor, cable or flexible cord is connected.

3.1.2 The minimum cross sectional area of any cable shall be determined by considering:

(a) The likely current to be carried.
(b) The maximum voltage drop permissible without adversely affecting the safe function of associated equipment served by the cable.
(c) Safe short-circuit temperature.
(d) The ambient temperature in which the cable is required to operate.

3.2 MAXIMUM SIZE OF SINGLE CONDUCTOR

3.2.1 Except as provided for in subclause 3.2.1.1 stranded conductors shall be used where the nominal cross-sectional area of the conductor exceeds 1.5 mm^2.

3.2.1.1 There shall be no maximum cross-sectional area necessary in respect of a single strand conductor for the following:

(a) Aluminium conductors.
(b) Switchboard and control panel wiring.
(c) Busbars.
(d) Collector or trolley wires.
(e) Earthing and bonding conductors.

3.3 DETERMINATION OF MINIMUM CABLE SIZE BASED ON CURRENT-CARRYING CAPACITY

To satisfy the current-carrying capacity requirements of a circuit it is necessary to take into account a number of factors. This is done by:

(a) Determining the current requirements of the circuit.
(b) Determining the environmental conditions in the vicinity of the cable.

(c) The resulting value of current represents the minimum current-carrying capacity required of the circuit. Taking into account the method of installation employed, the smallest conductor size, which has current-carrying capacity equal to or in excess of this predetermined minimum value, will be considered to be the minimum cable size satisfying the current-carrying capacity requirement.

Acceptable sizes of commonly used cables are given in Tables A1 to A6 of Appendix A to this Code for the calculated current to be carried by the cable, the method of installation and the environmental conditions of the cable.

3.4 DETERMINATION OF MINIMUM CABLE SIZE BASED ON VOLTAGE DROP

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. This is done by:

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

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

(c) Determining the maximum voltage drop (Vd) permitted on the circuit run.

e.g., $$Vd = \frac{L \times I \times Vc}{1000}$$

where

Vc	=	the millivolt drop per ampere-metre route length of circuit in millivolts per ampere metre (mV/A.m)
Vd	=	actual voltage drop, in volts
L	=	route length of circuit, in metres
I	=	the current to be carried by the cable, in amperes.

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

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. This is done by:

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

(b) Determining the initial and final conductor temperature.

(c) Calculating the minimum cross-sectional area of the cable. This cable size represents the minimum size required to satisfy the short-circuit temperature rise requirements.

e.g., $I^2t = K^2S^2$

where

I	=	short-circuit current (r.m.s. over duration), in amperes
t	=	duration of short circuit, in seconds (maximum of 5 seconds)
K	=	constant depending on the material of the current-carrying component, the initial temperature and the final temperature
S	=	cross-sectional area of the current-carrying component, in square millimetres.

SECTION 4

INSTALLATION OF CABLES

4.1 GENERAL

Cables shall be installed such that they are protected against mechanical damage.

4.2 LIMITATIONS ON USE OF SINGLE-CORE CABLE

4.2.1 Single-core cable armoured with steel armouring, including cables in conduit, shall not be used for alternating current.

4.2.2 Single-core cable, enclosed in lead or other non-ferrous metal sheathing may only be used for alternating currents where one of the following arrangements is employed:

(a) Trefoil formation.

(i) the cables are run in trefoil formation throughout their entire length except for a distance not exceeding 2 m at either end to facilitate termination of the cables; and

(ii) at the point where the trefoil formation ceases, the sheathing of the cables is bonded by a conductor of conductivity not less than that of the cable sheath.

(b) Other than trefoil formation.

(i) the cables are placed as near as practicable to each other (they may be touching); and

(ii) the sheathing of the cables is bonded at both ends, and at intervals not exceeding 30 m along the cable run if the cable is not served, by a conductor of conductivity not less than that of the cable sheath.

4.2.3 Where single core cables pass through plates of magnetic material or are enclosed by a fitting of magnetic material, provision shall be made to limit eddy currents.

4.2.4 The sheath of any single core cable coming within the scope of this subsection shall be earthed.

4.2.5 Cables of alternating current systems installed in steel ducts, troughs, or pipes shall be so bunched that the cables of all phases and the neutral (if any) are drawn into the same duct, trough, or pipe.

4.3 GROUPING OF CABLES

The cables of any alternating current circuit installed in a ferrous wiring enclosure shall be grouped so that the conductors of all phases and the related neutral, if any, are contained in the same wiring enclosure.

4.4 CABLE CONNECTIONS

4.4.1 Every cable connection shall:

(a) Be mechanically and electrically sound;

(b) Be protected against mechanical damage and any vibration liable to occur;

(c) Not impose any appreciable mechanical strain on the fixings of the connection; and

(d) Not cause any harmful mechanical damage to the cable conductor.

4.4.2 Connections shall:

(a) Be appropriate to the size of conductor with which they are to be used; and

(b) Be made at terminals of electrical appliance or by other means of connectors, mechanical clamps, crimping or compression fittings.

4.4.2.1 Where crimp, compression joints or mechanical clamps are made, the conductors shall not be tinned by soft soldering.

4.4.2.2 Crimp, mechanical clamps and compression joints shall be made so that the conductors are securely retained.

4.4.3 The conductivity of every joint or connection shall be at least equal to that of the conductor jointed or connected.

4.4.4 Joints between insulated cables shall be insulated to provide a degree of insulation not inferior to that of the cables.

4.4.5 Joints exposed to the weather or joints in underground wiring shall be sealed to prevent the entry of moisture.

4.4.6 Joints between cables having hygroscopic insulation, e.g., paper, shall be made to prevent the entry of moisture.

4.4.6.1 When cables having metallic sheathing or armouring are joined, the sheathing and armouring shall be made electrically continuous.

4.4.7 Where joints are made between cables having aluminium conductors, such connections shall be designed to take into account:

(a) The presence of aluminium oxide film;
(b) The different coefficients of linear expansion of aluminium and other metals;
(c) The relative softness of aluminium; and
(d) The prevention of corrosion.

4.4.8 Joints shall not be enclosed in a run of conduit unless made in conduit boxes.

4.4.8.1 Enclosure of joints is not necessary when the joints are made:

(a) In open wiring, as covered by subsection 4.14;
(b) At accessories;
(c) Within a switchboard or control panel;
(d) In the base blocks or bases of luminaries;
(e) By a method such that no further enclosure is necessary.

4.4.9 Junction boxes shall be installed so that:

(a) The wiring enclosure and sheathing of cables are brought into the junction box through close-fitting holes;
(b) The electrical continuity of metal wiring enclosure and cable sheathing, etc., is effectively maintained; and
(c) There is no undue pressure on conductors when the wiring enclosure and cover of the junction box are in position.

4.4.10 Connections between cables and flexible cords, other than flexible cords used as fixed wiring, shall be made only by means of a plug and socket-outlet, a ceiling rose, a cable connector, or other connecting device in which the conductors are rigidly clamped between metal surfaces.

4.5 STRESS ON TERMINALS, JOINTS AND CONNECTIONS

4.5.1 All cables and conductors shall be installed so that there is no undue stress on any connecting terminal, joint or connection.

4.5.2 Every flexible cord shall be installed so that stress on its connections due to a pull on the flexible cord is obviated by a pillar, post, grip, tortuous path, or other effective means of cord anchorage. Knotting of a flexible cord is not acceptable for this purpose.

4.6 TERMINAL CONNECTIONS

4.6.1 The connection of all conductors at terminals shall be made by clamping the conductors between metal surfaces in such a manner as will not allow the connection to slacken off under normal conditions of use. Clamping shall not depend for its effect on pressure on non-metallic materials or on metals of insufficient hardness for the purpose, which may flow or deform under the clamping pressure.

4.6.1.1 Terminals shall be of suitable corrosion-resistant material.

4.6.1.2 The requirements of Clause 4.6.1 shall not preclude:

(a) The use of festoon-type lamp holders, where contact with the conductor is made by penetration of the conductor insulation;

(b) The soldering of small conductors to terminals of relays and similar small fittings; or

(c) The sweating of a conductor into a solder lug.

4.6.2 Conductors having seven strands or more shall be terminated in one of the following ways:

(a) Clamped in a terminal having means to prevent the escape of strands from under the clamping device;

(b) Terminated in a compression fitting or terminating device; or

(c) Terminating of the conductor into a solder lug by soldering.

4.6.2.1 Stranded conductors shall not be terminated by soft soldering the conductors and clamping them under a clamping screw or between metal surfaces.

4.6.3 Aluminium conductor terminating devices shall be of a type designed to evenly distribute stress and to break the oxide film on the conductors.

4.6.4 Conductors shall be connected to a common terminal only by cable sockets, compression fittings or terminating devices, unless the form of the terminal ensures that all conductors are securely clamped at the terminals between metal contacts without the cutting away of conductor strands. If a single terminal is insufficient to accommodate all the conductors, multiple terminals or contacts with sufficient clamping devices to clamp the conductors securely shall be used.

4.7 CONNECTIONS BETWEEN FIXED WIRING AND FITTINGS

Fittings may be connected to the circuit wiring by direct connection or by connecting devices, i.e.:

(a) Direct connection. Rigid or flexible conduit enclosing insulated cables, or the sheathing of sheathed cables not required to be further protected, shall terminate in and be effectively secured to the fittings.

(b) Connecting devices. The fixed wiring shall terminate at a suitable outlet, socket-outlet, junction box, or other connecting device, the wiring to the fittings being continued by means of flexible cord or flexible cable, which shall be securely anchored at both ends.

4.8 SEGREGATION OF SERVICES

4.8.1 Cables operating at a voltage exceeding extra-low-voltage (ELV) or TNV, shall not be installed in the same duct, conduit, trough, trunking, as the cables of extra-low-voltage and TNV systems, unless the latter are insulated to the highest voltage present.

4.8.2 Where a common enclosure is used to contain cables insulated for different categories of circuit, those operating at ELV and TNV shall be effectually segregated from those operating at higher voltages.

4.8.3 Where controls or outlets for both categories of circuit are mounted in or on common boxes, switchplates, or blocks, the wiring and connections of those operating at ELV and TNV shall be separated from those operating at higher voltages by means of rigidly fixed screens or partitions.

4.9 ENCLOSURE OF CABLES

4.9.1 Cables, including flexible cords used as fixed wiring, shall be:

(a) Of a sheathed or double-insulated type; or

(b) Installed in a wiring enclosure throughout their entire length. Any covers of such wiring enclosures shall be effectively retained in position and shall not be removable without the use of tools.

4.9.1.1 The wiring enclosures referred to in paragraph (b) of clause 4.9.1 above shall not be required for unsheathed cables:

(i) run as aerial conductors or as open wiring;

(ii) run in a wall cavity between an accessory and a conduit or sheathing terminated within 100 mm of the hole over or within which the accessory is mounted;

(iii) used for switchboard or control panel wiring; or

(iv) within an enclosure.

4.9.2 Cables without sheathing or further enclosures shall not be installed in enclosures where they are accessible or where they may contact other services such as water, gas, hydraulic or communications systems.

4.10 OVERHEAD LINES OF LOW, AND EXTRA-LOW VOLTAGE

4.10.1 All conductors of every overhead line except trolley or collector wires shall be stranded.

4.10.2 Every overhead conductor or cable shall be effectively supported and terminated on suitable insulators. An overhead earth-continuity conductor or a catenary wire supporting an overhead cable may be attached and supported without the use of an insulator.

4.10.3 Covered, sheathed, or insulated conductors shall be so attached to insulators that their cover, sheath, or insulation is not damaged or likely to be damaged.

4.10.4 Single conductors and single-core cables that are not insulated for full working voltage shall be adequately spaced to prevent contact with each other under all conditions of sag and sway, The spacing between conductors at supports, measured in any direction, shall be not less than the following:

Span minimum spacing

Not exceeding 10 m	200 mm
Exceeding 10 m but not exceeding 30 m	350 mm
Exceeding 30 m but not exceeding 50 m	450 mm

4.10.5 Cables installed out-of-doors shall be suitable for exposure to direct sunlight.

4.11 CABLES SUPPORTED BY CATENARY WIRE

4.11.1 Cables supported by means of a catenary wire shall be stranded cables affording double insulation or the equivalent of double insulation.

4.11.2 The cable or cables shall be supported by the catenary wire as follows:

(a) A U-shaped cable loop not less than 0.15 m deep shall be provided before the first and after the last point of support to the catenary wire; and

(b) The cable or cables shall be attached to the catenary wire at intervals not exceeding 0.3 m and in a manner which will not cause damage to the cable.

An acceptable method of supporting cables by catenary wire is to:

(a) wrap the catenary wire in tape; and
(b) tape the cable to the wrapped catenary; and
(c) fasten the cable and catenary together with clips or straps.

Where cable or cables forming a catenary installation are in an indoor location and not likely to be disturbed, they may be supported by the catenary wire at intervals of not more than 1 m.

4.11.3 Catenary wires and supports shall comply with the following requirements:

(a) The catenary wire shall be of adequate strength to carry the load, and the length of any span shall not exceed 45 m;
(b) A catenary wire of hard-drawn copper or galvanised low carbon (mild) steel shall have a nominal cross-sectional area of not less than 8.5 mm^2;
(c) The catenary wire shall be firmly secured to wire rope thimbles and supported by means of suitable anchorages;
(d) All anchorages and any immediate supports shall be of adequate strength to support the load, including the effects of wind loading where appropriate;
(e) Polyester cord of sufficient strength to adequately support the cables may be used as a catenary wire in lieu of metal wire.

4.11.4 Where a catenary wire is used for earthing purposes, it shall have:

(a) Not less than seven strands; and
(b) A resistance not greater than that of a copper earthing conductor of the size required for that portion of the installation.

4.12 UNDERGROUND WIRING

4.12.1 Acceptable underground wiring systems are given in Table 1 below this subsection.

4.12.2 Wiring enclosures for underground cables shall be identified by a plastic marker strip installed at half trench depth during back-filling to ensure that early warning of the presence of the cable is given. Marker signs shall also be provided where any cable enters or leaves a building.

4.12.3 Cover of underground wiring systems shall be not less than that specified in Table 2 below this subsection.

4.12.4 Cables shall be bedded as follows:

(a) Category A system: No specific requirement;
(b) Category B system: Bedded in not less than 50 mm of sand or other granular non-cohesive material with a maximum particle size of 10 mm and covered by no less than 50 mm of such material;

(c) Category C system: Laid in an excavated channel and covered with granular non-cohesive material with a maximum particle size of 10 mm to a thickness of not less than 50 mm.

4.12.5 Additional mechanical protection shall be provided to Category B systems. Acceptable materials include:

(a) 50 mm thick Concrete;
(b) 25 mm thick Ground treated timber (H4);
(c) 12 mm thick Fibrous cement;
(d) 3 mm thick Polymeric cover strip.

These acceptable materials shall:

(a) Be not less than 150 mm wide;
(b) Overlap each side of the wiring system by at least 40 mm; and
(c) Be placed not more than 75 mm above the wiring system.

4.12.5.1 Neutral screen cable with 3.2 mm PVC insulating sheath requires no additional protection against mechanical damage as required by Clause 4.12.5.

TABLE 1

1	2	3	4	5	6`	7	8	9
Type of cable	Category A system				Category B system			Category C system
	Heavy duty rigid conduit to AS 2053 or light duty conduit to AS 2053 encased in concrete #	Heavy duty fibrous cement conduit to AS 2053	Medium and heavy duty galvanised steel tubes to AS 1074	Terracotta or fibrous cement pipe or ducting encased in concrete #	Terracotta or fibrous cement pipe not encased in concrete or polythene pipe	Flexible PVC conduit to AS2053, light duty conduit to AS 2053 or corrugated conduit to AS 2053	Buried direct	Chased in rock
(a) Unnearthed theromplastic insulated cables	X	-	-	-	-	X	-	-
(b) Elastomer or thermoplastic insulated cables, with elastomer, thermoplastic or lead alloy sheathing complying with AS 3116 or AS3147 for underground cables marked ' Underground'	X	X	X	X	X	X	X	-
(c) Armoured elastomer or thermoplastic insulated cables with bedding and serving or sheathing comply with AS 3116 or AS 3147	X	X	X	X	X	X	X	X
(d) Neutral screened cables having a sheathing and/or insulation complying with the requirements of AS 3155 for underground cables and marked as such	X	X	X	X	X	X	X	-
(e) Armoured paper insulated lead covered cables without serving or sheathing	X	X	X	X	X	X	-	-
(f) Armoured paper insulated lead covered cables with serving or sheathing	X	X	X	X	X	X	X	X
(g) Unarmored paper insulated lead covered cables without serving or sheathing	X	X	-	X	X	X	-	-
(h) Unarmored paper insulated lead covered cables with serving or sheathing	X	X	X	X	X	X	-	-
(i) Served copper and aluminium MIMS cables	X	X	X	X	X	X	X	X
(j) Aluminium sheathed or strip armoured cables with PVC serving	X	X	X	X	X	X	X	X

X denotes acceptable method.

Concrete shall be 50 mm thick.

TABLE 2

MINIMUM DEPTH OF LAYING AND PROTECTION OF UNDERGROUND WIRING

Category of system	Minimum cover of cable (metre)		
	Areas subjected to vehicular traffic	**Paved areas, but not subjected to vehicular traffic**	**Other locations**
A	0.6	Directly below concrete	0.3
B	0.6	0.3	0.5
C	0.05	0.05	0.05

4.13 BARE CONDUCTORS OTHER THAN OVERHEAD AND EARTHING CONDUCTORS

4.13.1 Bare conductors shall not be smaller than 6 mm^2.

4.13.2 Bare conductors shall be installed:

(a) So that they are not accessible to direct contact without the use of a tool; or

(b) In positions where only authorized persons have access; or

(c) At a height above ground, floor or platform of:

(i) 4 m where the area beneath the bare conductor is not subject to vehicular traffic other than a vehicle which depends on the conductors for the supply of current; or

(ii) 5.5 m where the area beneath the bare conductors is subject to vehicular traffic other than that covered by sub-paragraph (i) of this paragraph.

4.13.3 Bare conductors shall be supported on insulators, and spaced or strained so that adequate clearance between the conductors themselves, and between the conductors and any material other than their supporting insulators, is maintained under all conditions.

4.13.3.1 This spacing requirement need not apply to bare conductors connected in parallel.

4.13.4 Bare conductors shall be controlled by an isolating switch:

(a) Located in the proximity of the bare conductors in a position so as to allow operation from ground level; and

(b) Which allows all phase conductors to be simultaneously isolated and kept isolated from the supply; and

(c) Arranged in accordance with subclause 4.13.4.1; and

(d) Marked in accordance with subclause 4.13.4.2.

4.13.4.1 The isolating switch required by Clause 4.13.4 may be arranged for either manual or remote control.

The switch or the remote means of control shall be capable of being locked in the open position.

4.13.4.2 At the operating point of the switch required by Clause 4.13.4:

(a) There shall be fixed a prominent notice indicating that the switch controls the bare conductors; and

(b) Provision shall be made for positive visual indication as to whether the switch is 'on' or 'off'.

In respect of paragraph (b) of this subclause, a switch is acceptable which has open blades whose position can be clearly seen, or which is provided with a clearly visible indicating flag. If the isolating switch is a magnetic switch or contactor, the indicating means shall be of a form which can show 'safe' only when the magnetic switch is off. Indication by lamps alone is not acceptable.

4.13.5 Conspicuous, legible and indelible danger notices shall be provided in suitable positions:

(a) Adjacent to the bare exposed conductors at each termination; and

(b) At intervals of not more than 15 m along the run of bare exposed conductors; and

(c) In each room where the bare exposed conductors are located within more than one room in a building.

4.14 OPEN WIRING

4.14.1 Thermoplastic insulated cables may be used without the protection of conduit or sheathing only if they are installed in accordance with the requirements of this subsection.

4.14.2 Cables installed as open wiring shall be open to view throughout their entire length, though not necessarily from one point.

4.14.2.1 Cables need not be open to view when installed in accordance with Clauses 4.14.5 and 4.14.6.

4.14.3 Cables installed as open wiring shall be spaced sufficiently far apart to prevent contact with each other.

4.14.3.1 Cables installed as open wiring shall be supported so that they are maintained at a distance of not less than 25 mm vertically above, and not less than 20 mm horizontally from, any structure.

4.14.3.2 This spacing need not be provided at supports or where the cables pass through wiring enclosures.

4.14.4 Cables installed as open wiring shall be supported on insulators or secured by suitable cleats, clips, saddles or clamps.

Such cleats, clips, saddles or clamps shall:

(a) Be made of suitable insulating material; and

(b) Have smooth or rounded edges which will not damage the insulation; and

(c) Be designed and placed so that the clearances required by Clause 4.14.3 are maintained.

4.14.4.1 Where the distance between supports exceeds 3 m, any run exceeding 15 m in length shall be terminated on shackles or other suitable strain insulators, unless it is clamped or fixed at each support.

4.14.4.2 The maximum distance between supports for different sizes of cables and means of support is that shown in Table 3 below this subclause. The maximum distance between supports for clear runs as in open roofs and along walls shall be that given in the said Table 3, but additional support may be necessary in order to comply with the requirements of Clause 4.14.3.

TABLE 3

OPEN WIRING - DISTANCE BETWEEN SUPPORTS

Type and size of cable	Means of support	Distance between supports, m	
		Cables approximately horizontal	**Cables approximately vertical**
Single strand ≤ 2.5 mm^2	Saddles, cleats, clips or insulators	1.5	2.0
Stranded cable ≤ 2.5 mm^2	Saddles, cleats, clips or insulators	2.0	3.0
	Insulators	4.5	4.5
Stranded cable > 2.5 ≤ 16 mm^2	Saddles, cleats, clips or insulators	2.0	3.0
	Insulators	9.0	9.0
Stranded cable > 16mm^2	Saddles, cleats, clips or insulators	2.0	3.0
	Insulators	12.0	12.0

4.14.5 Cables installed as open wiring shall be adequately protected by conduits, pipes, casings, ducts or the like where they are:
(a) Liable to mechanical damage; or
(b) Within 2 m above the floor if inside a building; or
(c) Within 2.5 m of the ground if exposed to the weather.

4.14.6 Where passing through floors, partitions, walls or ceilings, cables installed as open wiring shall be:
(a) Protected by conduits or ducts; or
(b) Supported on insulators so that the clearances specified in Clause 4.14.3 are provided.

4.14.6.1 Where passing through fire-rated floors, partitions, ceilings or walls, the cables shall be protected by non-combustible conduits or ducts and shall be sealed to restore the fire resistance to at least the equivalent of the fire barrier penetrated.

4.15 UNSHEATHED CABLES

4.15.1 Unsheathed cables shall be enclosed throughout their entire length in accordance with subsection 4.9.

4.15.2 Unsheathed cables installed in concrete shall be enclosed in one of the following wiring enclosures:

(a) Screwed metallic conduit;
(b) Rigid non-metallic conduit;
(c) UPVC pipes;
(d) Corrugated conduit.

4.16 ARMOURED AND UNARMORED LEAD SHEATHED, ELASTOMER SHEATHED AND THERMOPLASTIC SHEATHED CABLES

4.16.1 Sheathed cables may be used without the protection of wiring enclosure only if they are installed in accordance with the requirements of this subsection.

4.16.2 Armoured cables with serving may be installed in concrete or plaster without further enclosure or restriction on the length or direction of the cable run.

4.16.3 Unarmored sheathed cables may be installed in concrete provided that the cables are contained in one of the following wiring enclosures:

(a) Screwed metallic conduit;
(b) Rigid non-metallic conduit;
(c) UPVC pipes;
(d) Steel tube;
(e) Corrugated conduit.

4.16.4 Unarmored sheathed cables shall not be installed in positions where they are likely to be subject to mechanical damage.

4.16.5 Where cables are passed through holes in wooden joists, they shall be mechanically protected against driven nails, or shall be installed not less than 50 mm from the underside of any floorboards.

4.16.6 Cables installed in positions where they are likely to be disturbed shall be fixed at intervals to prevent undue sagging.

4.16.6.1 Fixings shall be spaced at intervals of not more than 0.3 m apart for cables installed in the following positions:

(a) Surface wiring on a wall or on the underside of the ceiling;
(b) Wiring in a space between floor and ground to which a person may gain access;

(c) Wiring within 2 m of any access to any space to which a person may gain entry.

4.16.6.2 Fixings shall be spaced at intervals of no more than 1.2 m apart for cables installed in a ceiling space having an access space exceeding 0.6 m high, if the cables are in a position where they are likely to be stood on.

4.16.6.3 Where cables are installed horizontally in positions in which they are not likely to be disturbed, no fixings need be provided if the cables rest on a continuous surface; in other cases they shall be supported at intervals of not less than 2 m apart.

4.16.6.4 Where cables are installed vertically in positions in which they are not likely to be disturbed, they shall be fixed at intervals of not more than:

(a) For armoured sheathed cables .....3 m; or
(b) For unarmored sheathed cables .....7.5 m.

4.16.7 Where cables are required to change direction, the following requirements shall apply:

(a) Cables shall be bent in a manner that will neither cause damage nor place undue stress on their sheathing or insulation;
(b) Unarmored sheathed cables shall be bent so that the internal radius of the bend is not less than 6 times the cable diameter;
(c) Armoured sheathed cables shall be bent so that the radius of the bend is not less than 12 times the cable diameter;
(d) Where a change of direction is likely to cause excessive pressure on any part of a cable, the cable shall be brought over a support from which any sharp edges have been removed.

4.16.8 Fixings shall be constructed of suitable materials so as to not cause damage to the cables.

4.17 NEUTRAL SCREENED CABLES

4.17.1 Neutral-screened cables used for fixed wiring, other than aerial cables, shall be of the tough-plastic-sheathed type having annealed copper or aluminium conductors.

4.17.2 Where a connection is made between a neutral-screened cable and any other type of cable, or where a neutral-screened cable is connected to any terminal except at a switchboard or within fittings, the connection shall be effected within a suitable connector box and the protective coverings of the cable shall be brought within the box. Where the connector box is exposed to the weather it shall be so constructed and installed as to prevent the entry of moisture into the box or into the cable.

4.17.3 Tough-plastic-sheathed neutral-screened cable with annealed copper conductors may be used unbroken as an overhead line and a service main, or a submain, or circuit wiring, that is to say, without the junction requiring an overhead-line connector box.

4.17.4 The surrounding outer conductor of a neutral-screened cable shall be used only as a neutral conductor or as an earthing conductor.

4.18 ALUMINIUM CABLES AND CONDUCTORS

4.18.1 The provisions of this subsection apply to cables with:
(a) Aluminium conductors;
(b) Aluminium conductors clad or coated with copper or other metals; and
(c) An outer conductor, armouring or sheathing of aluminium.

4.18.2 Aluminium cables may be welded, soldered, or compression jointed.

4.18.3 Bolted or clamped connections shall be designed to take into account aluminium oxide film, different coefficients of linear expansion of aluminium and other metals, and the relative softness of aluminium.

4.18.4 Aluminium conductors shall not be used as earthing conductors.

4.18.5 Aluminium cable sheaths shall not be installed in contact with:
(a) Metals with which they are liable to set up galvanic action; or
(b) Materials such as hardwood, damp brickwork, concrete, or plaster, with which corrosion may occur.

4.18.6 Aluminium sheathed cables shall not be bent at a radius less than that given in Table 4 below this subsection.

4.18.7 The following aluminium cables shall not be buried direct in the ground or installed in damp situations:
(a) Cables with serving not impervious to moisture;
(b) Cables with bare aluminium sheaths;
(c) Cables with bare aluminium strip armour.

4.18.8 Aluminium concentric conductors shall be terminated in accordance with the requirements for neutral-screened cables outlined in subsection 4.17.

TABLE 4

MINIMUM BENDING RADIUS FOR ALUMINIUM SHEATHED CABLES

1	2
Overall diameter of cable mm	Minimal internal radius of bend
<15	8 times overall diameter of cable
>15 <20	10 times overall diameter of cable
>20 <30	12 times overall diameter of cable
>30 <50	15 times overall diameter of cable
>50	18 times overall diameter of cable

4.19 FLEXIBLE CORDS

4.19.1 The following flexible cords may be used for fixed wiring:

(a) Heavy duty sheathed cords with conductor size of 1.00 mm^2 or greater;

(b) Sheathed metallic screened, and sheathed overall cords, with a size of 1.00 mm^2 or greater.

4.19.2 Tinsel flexible cord shall not be used for fixed wiring.

4.19.3 Joints between flexible cords, or between a flexible cord or other conductors used for fixed wiring, shall be made in either a junction box or other suitable enclosure.

4.19.4 Flexible cords with metal braid screening, except those permitted for use in hazardous locations, shall be used only for short connections between component parts of appliances or machines.

4.19.5 A flexible cord shall only be used to support a luminaire or fitting associated with that flexible cord.

SECTION 5

WIRING ENCLOSURES, CONDUITS AND CABLE TROUGHING

5.1 WIRING ENCLOSURES

5.1.1 Acceptable wiring enclosures for the protection of cables include:

(a) Steel conduits or other metallic tubing or conduit, with screw-grip fittings, provided that these shall in no case be of a type wherein a grub-screw projects into the fitting and tends to indent the conduit;
(b) Steel conduits or metallic tubing or conduit with screwed fittings or piping with screwed fittings;
(c) Flexible metal conduit;
(d) Rigid and flexible non-metallic conduit;
(e) Corrugated non-metallic conduit;
(f) Cable troughing with or without compound filling;
(g) Other wiring enclosures providing at least the equivalent protection of those listed in the above paragraphs of this clause.

5.1.2 If more than one type of wiring enclosure is used for the protection of cables, any change from one enclosure to another shall be made:

(a) At a switchboard or control panel; or
(b) By means of a suitable device which provides for the complete protection of the conductor insulation and for continuity of the wiring enclosure.

5.1.3 Wiring enclosures shall be:

(a) Installed in a manner that will prevent water from entering electrical fittings and enclosures; and
(b) Where exposed to the weather, be provided with adequate means to prevent the entry of water.

5.1.4 Where wiring enclosures are run vertically, adequate provision shall be made for the support of the enclosed cables.

5.2 METALLIC CONDUITS AND FITTINGS

5.2.1 Metallic conduit may be used for the protection of cables in the following situations:

(a) Where exposed to severe mechanical damage;
(b) In hazardous areas;
(c) For the supply to fire protection equipment and lifts;
(d) Where ambient temperatures exceed 60 degrees C;
(e) Where protection is required against risk of fire.

5.2.2 Cables may be enclosed in steel tubes and fittings, where such tubes and fittings:

(a) Have no internal burrs and other projections; and
(b) Have a protective coating which is adequate for the application; and
(c) Are installed in accordance with all other requirements of this Code for the installation of screwed conduit.

5.2.3 Conduit, tubing or piping of other materials may be used in place of steel conduits, provided that they afford adequate mechanical protection of the conductors and electrical continuity in order to comply with other relevant requirements of this Code.

5.2.4 Metallic conduits and fittings shall be installed in accordance with the following requirements:

(a) They shall not be bent in a manner which distorts the walls from their original section or opens a joint or weld in the conduit or pipe; and
(b) They shall be supported by saddles, clips, or pipe hooks, spaced not more than 2 m apart and in a manner so as to hold the conduit or pipe in position without sagging. Spring clips shall not be used in situations subject to movement or vibration, or where conduits are likely to be disturbed; and
(c) The mechanical and electrical continuity of the conduit shall be maintained.

5.2.4.1 Conduit ends shall be provided with a bellmouth or bush to prevent abrasion of cables on the conduit.

5.2.4.2 Terminations shall be arranged so that conduits and fittings terminate in and are supported on fittings in such a manner as to fully protect the enclosed cables as they pass into the fittings.

5.2.4.3 All elbows and tees shall be of the inspection type, and no bend having a radius less than 2.5 times the outside diameter of the conduit shall be used. Non-inspection conduit fittings may be used in the following situations:

(a) At the end of conduits adjacent to accessories or luminaries;
(b) In surface wiring where the conduit turns to pass through a wall, in which case a non-inspection elbow may be used if the conditions are such as would make the use of an inspection elbow or normal bend impracticable; and
(c) In inaccessible positions, such as in a hollow partition or where conduit is to be buried in concrete, in which cases a non-inspection elbow may be used if it is impracticable to use a normal bend.

5.2.5 Where conduits and fittings are installed in a position exposed to severe risk of mechanical damage, additional means of protection shall be provided.

5.2.5.1 Where conduits and fittings are exposed to the action of corrosive fumes or liquids, they shall be:

(a) Galvanised, sheradised and coated with acid-resisting or alkali-resisting paint as appropriate to the service conditions; or

(b) Otherwise treated by a process that will provide protection against corrosion under service conditions.

5.2.5.2 Steel piping used in positions exposed to the weather shall be galvanized, sheradised, enamelled or otherwise protected against corrosion.

5.2.5.3 Conduits and fittings shall not be used in direct contact with concrete, precast concrete bricks or blocks, nor with like materials that contain coke breeze or cinder.

5.2.5.4 Where the protective coating of a conduit or fitting has been damaged, it shall be effectively restored by paint or other suitable coating.

5.3 FLEXIBLE CONDUIT

5.3.1 Flexible conduits shall be installed in accordance with the requirements of this subsection.

5.3.2 Flexible metallic conduit shall not be used in situations such as those listed in Clause 5.2.1.

5.3.2.1 Flexible non-metallic conduit shall not be installed in the following situations:

(a) Where exposed to risk of severe mechanical damage;

(b) Where embedded in concrete;

(c) In hazardous areas, unless enclosing intrinsically safe circuits;

(d) Where used to enclose the supply cables to fire protection equipment and lifts.

5.3.3 Flexible metallic conduit shall not be relied upon for the earthing of any luminaire or accessory.

5.3.4 The ends of flexible conduit shall be securely anchored to the fixed conduit, structure or fittings to which it is attached using conduit fittings.

5.3.5 Runs of flexible conduit shall be supported at intervals to prevent excessive stress or sag.

5.3.5.1 Where a flexible conduit is installed in a position where it is likely to be disturbed, it shall be suitably supported.

5.3.5.2 Horizontal runs of flexible metallic conduits installed in positions where they are not likely to be disturbed shall be supported at intervals not exceeding 1 m, and vertical drops shall be supported at intervals not exceeding 2 m.

5.3.6 Fittings used for attaching and anchoring flexible metallic conduit shall:

(a) Maintain effective electrical continuity where required; and

(b) Be of a type which will hold the flexible conduit securely in position without distorting it.

Where a compression type fitting is used to provide electrical continuity, it shall not compress or include non-metallic material within the fitting. Grip-conduit fittings shall not be of a type where a grub-screw projects into a fitting and tends to indent the flexible metallic conduit.

5.3.6.1 Fittings used for attaching and anchoring flexible non-metallic conduit shall be of a type which will hold the flexible conduit securely in position without unduly distorting it.

5.4 RIGID NON-METALLIC CONDUITS

5.4.1 Rigid non-metallic conduit and fittings shall be installed in accordance with the requirements of this subsection.

5.4.2 Rigid non-metallic conduit and fittings shall be considered suitable for the following applications:

(a) Light duty:
  (i) above ground, in positions not exposed to the risk of mechanical damage;
  (ii) underground, in Category B systems only.

(b) Heavy duty:
  (i) above ground;
  (ii) underground.

(c) Oval type:
  Where concealed and protected, such as by the rendering of the masonry walls.

5.4.3 Rigid PVC conduit and fittings shall not be installed in the following locations:

(a) Where protection is required against the risk of fire;

(b) In hazardous areas unless enclosing intrinsically safe circuits;

(c) In ambient temperature below -15 degrees C or above 60 degrees C;

(d) Where subject to harmful conditions, e.g. in the presence of solvents.

5.4.4 Conduits shall not be bent in a manner that will cause appreciable distortion from their original section, and shall be adequately supported.

5.4.4.1 All joints between rigid PVC conduit and conduit fittings shall be made by means of an adhesive cement.

5.4.4.2 Rigid PVC conduit and conduit fittings installed in direct sunlight shall be:
(a) Of a type specially treated for such use; or
(b) Painted with a light coloured water-based acrylic paint.

5.4.4.3 Where conduits and fittings are installed in positions where they are exposed to mechanical damage, additional means of protection shall be provided.

5.5 CORRUGATED NON-METALLIC CONDUIT

5.5.1 Corrugated non-metallic conduit may be used in the following situations:
(a) Underground, in Category B systems only;
(b) Embedded in concrete;
(c) Above ground, in positions not exposed to mechanical damage.

5.5.2 Corrugated conduit shall not be used in the following situations:
(a) Where exposed to mechanical damage;
(b) For the enclosure of supply cables to fire protection equipment and lifts;
(c) In hazardous areas unless enclosing intrinsically safe circuits.

5.5.3 Joints and terminations made with corrugated conduit shall be made by fittings designed for corrugated conduit.

5.5.3.1 Corrugated conduit shall be supported in the same manner as specified for non-metallic conduit in Clause 5.3.5.

5.6 NUMBER OF CABLES IN A CONDUIT, TUBE OR PIPE (METALLIC AND NON-METALLIC)

The maximum number of cables that may be enclosed in a conduit, tube or pipe shall be an amount which permits installation of the cables without damage.

5.7 CABLE TROUGHING

5.7.1 Cable troughing shall be provided with covers over its entire length except where:
(a) Used only for the installation of sheathed cables and earthing conductors; and
(b) Installed in a position unlikely to be disturbed.

5.7.1.1 Covers shall be able to be opened, as far as practicable, for the purpose of laying cables in the troughing. Ends of cable troughing shall not be left open.

5.7.1.2 Covers shall be continuous where passing through walls and floors.

5.7.2 Cable troughing shall be accessible throughout its entire length for the inspection and repair of the enclosed cables.

5.7.2.1 Cable troughing shall not be installed:
(a) In hazardous areas; or
(b) In positions exposed to mechanical damage; or
(c) In damp situations.

5.7.2.2 Switches and circuit-breakers shall not be located within cable troughing.

5.7.2.3 Fittings shall not be mounted on any readily removable portion of cable troughing.

5.7.3 Cables shall be so installed in troughing so as not to prevent free circulation of air or dissipation of heat.

5.7.3.1 Cables installed in cable troughing:
(a) Shall not rely on any readily removable cover for support in the troughing; and
(b) Shall be fixed so that on removal of any cover, the cables remain within the troughing.

5.7.3.2 Cable troughing shall be installed so that:
(a) Foreign matter is excluded;
(b) No appreciable condensation of moisture can occur; and
(c) No water can lie within the cable troughing.

5.7.3.3 Where cable troughing is run vertically, adequate provision shall be made for the support of the weight of the cable without the likelihood of damage to the insulation of the cable and cable supports.

5.7.4 Where cable troughing is installed in a position exposed to the weather and is used to enclose cables which may be effected by moisture, it shall be of a type complying with AS 1939 with degree of protection complying with IPX3, and shall be so installed as to prevent the ingress of moisture.

5.7.5 Cable troughing and its cover shall be in an unbroken length where passing through walls, floors or ceilings.

5.7.5.1 Where cable troughing passes through a fire-rated wall, floor, or ceiling, it shall be sealed to maintain the fire rating of the barrier penetrated.

5.7.6 Metal cable troughing in an installation shall not be used as an earthing medium for any other part of the installation.

APPENDIX A

CURRENT CARRYING CAPACITIES OF CABLES

INDICATIVE TABLES

Notes to Current Rating Tables

1. Current ratings are for CLOSE protection

2. Conditions of installations:-

Ambient air temperature:	30°C
Soil temperature:	15°C
Soil thermal resistivity:	12°C.m/W
Depth of laying:	0.5m (to the centre of cable or trefoil group of cables)

For variations in air temperature:

Ambient temperature, °C	25	35	40	45	50	55	60	65	70	75	80
PVC correction factor	1.06	0.94	0.87	0.79	0.71	0.61	0.50	0.35	N/A	N/A	N/A
XLPE correction factor	1.04	0.96	0.91	0.87	0.82	.076	0.71	.065	.058	0.50	0.41

For variations in soil temperature:

Soil temperature, °C	20	25	30	35	40
PVC correction factor	0.95	0.90	0.85	0.81	0.75
XPLE correction factor	0.97	0.93	0.89	0.86	0.82

TABLE A1

Current carrying capacities of single core PVC insulated unarmored sheathed & unsheathed cables 600/1000V. (Close protection) Copper conductors

Conductor sizes mm^2	Clipped Direct		Unenclosed in air		Enclosed conduit in air		Partially enclosed in thermal insulation		Buried direct		Single way ducts	
	1ph	3ph	1ph	3ph	1ph	3ph	1ph	3ph	1ph	3ph	1ph	3ph
1.0	17	16	17	16	14	12	11	10	27	14	27	14
1.5	21	20	21	20	17	15	14	13	35	19	35	19
2.5	30	26	30	26	24	21	20	18	46	25	46	25
4	40	36	40	36	32	29	26	24	59	35	59	35
6	50	56	50	45	41	37	34	31	74	45	74	45
10	68	61	68	61	56	52	46	42	99	62	99	62
16	90	81	90	81	74	68	61	56	137	121	126	121
25	118	106	131	110	97	88	80	73	187	160	170	160
35	145	130	162	137	120	110	99	89	214	182	198	187

Voltage loop drop of single core PVC insulated unarmoured cables Copper conductors

Conductor sizes mm^2	Two core cable Single phase AC or DC	Three or four core cable Three phase
	mV/Amp/metre	mV/Amp/metre
1.0	40	35
1.5	60	26
2.5	16	14
4	10	8.8
6	6.8	5.9
10	4.0	3.5
16	2.6	2.2
25	1.6	1.4
35	1.2	1.0

TABLE A2

Current carrying capacities of twin & multi-core PVC insulated unarmored sheathed & unsheathed cables 600/1000V. (Close protection) Copper conductors

Conductor sizes mm^2	Clipped Direct		Unenclosed in air		Enclosed conduit in air		Partially enclosed in thermal insulation		Single way ducts	
	1ph	3ph	1ph	3ph	1ph	3ph	1ph	3ph	1ph	3ph
1.0	16	13	16	13	14.5	12	11	10	18	16
1.5	20	17	20	17	17	16	14	13	24	20
2.5	28	24	28	24	24	21	20	18	31	27
4	36	32	36	32	32	29	26	24	41	35
6	46	40	46	40	40	36	34	31	52	44
10	64	54	64	54	53	49	46	42	70	60
16	85	72	85	72	70	63	61	56	90	77
25	120	100	120	100	88	79	80	73	125	105
35	140	115	140	115	105	92	99	89	145	120

Voltage loop drop of flat twin & multi-core PVC insulated unarmoured cables Cable conductors

Conductor sizes mm^2	Two core cable Single phase AC or DC	Three or four core cable Three phase
	mV/Amp/metre	mV/Amp/metre
1.0	40	35
1.5	27	26
2.5	16	14
4	10	8.8
6	6.8	5.9
10	4.0	3.5
16	2.6	2.2
25	1.6	1.4
35	1.2	1.0

TABLE A3

Current carrying capacities of multi-core PVC insulated unarmored sheathed & unsheathed cables 600/1000V. (Close protection) Copper conductors

Conductor sizes mm^2	Clipped Direct		Unenclosed in air		Enclosed conduit in air		Partially enclosed in thermal insulation		Buried direct		Single way ducts	
	1ph	3ph	1ph	3ph	1ph	3ph	1ph	3ph	1ph	3ph	1ph	3ph
1.0	15	14	17	14.5	13	11.5	11	10	24	21	21	17
1.5	20	18	22	19	16	15	14	13	30	26	26	22
2.5	27	24	30	255	24	20	19	18	40	34	34	29
4	36	32	40	34	30	27	25	23	53	45	44	37
6	46	41	51	43	38	34	32	29	66	57	55	47
10	63	57	70	60	52	46	43	39	88	75	73	62
16	85	76	94	80	69	62	57	52	115	98	96	80
25	112	96	120	101	90	80	75	68	150	130	125	105
35	138	120	148	130	111	100	92	83	185	155	150	125

Voltage loop drop of multi-core PVC insulated unarmoured cables Copper conductors

Conductor sizes mm^2	Two core cable Single phase AC or DC	Three or four core cable Three phase
	mV/Amp/metre	mV/Amp/metre
1.0	40	35
1.5	28	24
2.5	17	15
4	11	9.1
6	7	6
10	4.1	3.6
16	2.6	2.2
25	1.7	1.5
35	1.2	1.0

TABLE A4

Current carrying capacities of single core XPLE insulated unarmored sheathed & unsheathed cables 600/1000V. (Close protection) Copper conductors

Conductor sizes mm^2	Clipped Direct		Unenclosed in air		Enclosed conduit in air		Partially enclosed in thermal insulation		Buried direct		Single way ducts	
	1ph	3ph	1ph	3ph	1ph	3ph	1ph	3ph	1ph	3ph	1ph	3ph
1.0	22	20	22	20	18	16	15	11	32	18	32	18
1.5	27	25	27	25	23	20	19	13	40	23	40	23
2.5	36	34	36	34	31	27	27	19	53	32	53	32
4	48	45	48	45	42	37	35	31	68	42	68	42
6	61	57	61	57	51	48	44	39	85	55	85	55
10	84	78	84	78	74	66	61	55	116	76	116	76
16	111	103	120	108	100	89	81	72	160	138	143	138
25	155	142	161	148	135	120	110	101	215	182	198	182
35	183	170	201	176	164	144	132	115	242	209	226	209

Voltage loop drop of single core XPLE insulated unarmoured cables Copper conductors

Conductor sizes mm^2	Two core cable Single phase AC or DC	Three or four core cable Three phase
	mV/Amp/metre	mV/Amp/metre
1.0	46	40
1.5	31	27
2.5	19	16
4	12	10
6	7.9	6.9
10	4.7	4.1
16	2.9	2.5
25	1.9	1.6
35	1.4	1.2

TABLE A5

Current carrying capacities of multi-core XPLE insulated unarmored sheathed & unsheathed cables 600/1000V. (Close protection) Copper conductors

Conductor sizes mm^2	Clipped Direct		Unenclosed in air		Enclosed conduit in air		Partially enclosed in thermal insulation		Buried direct		Single way ducts	
	1ph	3ph	1ph	3ph	1ph	3ph	1ph	3ph	1ph	3ph	1ph	3ph
1.0	18	15	20	18	14	13	14	13	24	24	24	20
1.5	23	20	25	23	19	18	19	18	30	30	30	5
2.5	31	26	35	32	26	24	26	23	41	41	41	34
4	41	35	47	43	36	32	35	31	53	53	53	44
6	52	45	62	55	46	42	45	40	83	68	67	55
10	73	62	85	76	65	58	62	55	110	91	90	75
16	108	95	114	100	87	77	81	73	140	115	115	94
25	144	126	152	133	121	108	116	101	180	150	145	125
35	181	153	190	160	143	127	132	116	215	180	175	150

Voltage loop drop of multi-core XPLE insulated unarmoured cables Copper conductors

Conductor sizes mm^2	Two core cable Single phase AC or DC	Three or four core cable Three phase
	mV/Amp/metre	mV/Amp/metre
1.0	46	40
1.5	31	27
2.5	19	16
4	12	10
6	7.9	6.9
10	4.7	4.1
16	2.9	2.5
25	1.9	1.7
35	1.4	1.2

TABLE A6

CURRENT CARRYING CAPACITIES OF FLEXIBLE CORDS

Current rating and associated voltage drops for flexible cords

1	2	3	4
Conductor size	Current carrying capacity a,b,d,e	Volt drop per ampere per metre	
mm^2	A	d.c. or single phase a.c. mV	Three phase a.c. mV
1	10	43	37
1.25	13	35	29
1.5	16	31	26
2.5	20	18	16
4	25	11	96

a Where a flexible cord is wound on a drum, multiply current carrying capacity by the following factor:

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

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

c The current carrying capacity is based on a cable maximum operating temperature of 60°C in order to limit high temperatures for the expected use of such cables.

d To determine the single phase voltage drop, multiply the 3 phase value by 1.155.