5.6.3.3 *Conductor material and type*

Main earthing conductors shall be of high conductivity copper in accordance with Clause 5.5.2.1, or other material that complies with Clause 5.5.2.2.

A2 **5.6.3.4** *Insulation and identification*

5.6.3.4.1 *General*

Main earthing conductors shall be insulated and identified in accordance with Clause 5.5.3.

5.6.3.4.2 *Labelling* **NZ** **NZR**

In New Zealand, the main earthing conductor shall be permanently labelled at both ends with a warning against disconnection.

5.6.3.5 *Installation*

Main earthing conductors shall be installed in accordance with Clause 5.5.4.

5.6.3.6 *Connections*

All connections in main earthing conductors shall comply with Clause 3.7.

5.6.3.7 *Connection to earth electrode*

The connection of the main earthing conductor to the earth electrode shall be —

(a) accessible for visual inspection and for the purposes of disconnection and testing; and

(b) made by means of a suitable device that provides adequate electrical conductivity; and

(c) suitably protected from mechanical damage likely to occur at the location; and

(d) suitably protected against corrosion.

5.6.4 Main earthing terminal/connection or bar

5.6.4.1 *General*

In every electrical installation a main earthing terminal/connection or bar shall be provided at the main switchboard and the following conductors shall be connected to it:

(a) Main earthing conductor.

(b) MEN link.

(c) Protective earthing conductors.

(d) Functional earthing conductors, if required.

(e) Equipotential bonding conductors.

NOTE: A main earthing terminal/connection may be a soldered connection.

5.6.4.2 *Disconnection arrangements for resistance measurement*

Means shall be provided in an accessible position for disconnecting the main earthing conductor in order to permit measurement of the resistance of the earthing system.

This connection shall be such that it can only be disconnected by means of a tool, is mechanically robust, and will reliably maintain its electrical conductivity.

5.6.4.3 *Main earthing bars*

Each main earthing bar shall comply with the requirements of Clause 2.9.3.

5.6.5 MEN Link

5.6.5.1 *General*

In general, a connection shall be made at the main switchboard from the main earthing terminal/connection or bar to the earthing terminal on the main neutral link.

This does not preclude the connection being made at a substation instead of a switchboard.

5.6.5.2 *Size*

The MEN link shall be a conductor complying with Clause 5.5.2 and have a cross-sectional area not less than that of the main earthing conductor.

Where consumers mains are not protected on the supply side by short-circuit protective devices the MEN link shall have a cross-sectional area not less than that of the main neutral conductor.

5.6.5.3 *Identification*

Where the MEN link is insulated, the insulation shall be coloured in a combination of green and yellow in accordance with Clause 5.5.3.

5.6.6 Earthing in outbuildings and detached portions of an electrical installation

All parts of an electrical installation in an outbuilding or detached portion of an electrical installation that are required to be earthed in accordance with Clause 5.4 shall be earthed by one of the following methods:

(a) *Connection to the electrical installation earthing system* The earthing system in the outbuilding shall be connected to a protective earthing conductor connected in accordance with Clause 5.6.7.2.

(b) *Separate MEN installation* The electrical installation in the outbuilding shall be regarded as a separate electrical installation, and shall be earthed in accordance with other relevant Clauses of this Standard and with the following requirements:

(i) There shall be not more than one MEN connection in any one outbuilding.

(ii) The distribution board in the outbuilding shall be regarded as a main switchboard only for the purpose of effecting the MEN connection.

(iii) The submain supplying the outbuilding shall be run either —

(A) directly from the main switchboard; or

(B) from the main switchboard via distribution boards in one or more other outbuildings, to one distribution board only in the outbuilding.

(iv) Where the neutral conductor supplying the distribution board in the outbuilding runs from the main switchboard via distribution boards in one or more other outbuildings, the terminals on such distribution boards shall not be depended upon for continuity of the neutral conductor.

(v) The neutral conductor supplying the distribution board in the outbuilding should not be connected in parallel, by means of earthing or equipotential bonding conductors, with metallic pipes or structural metal within the electrical installation.

5.6.7 Protective earthing conductors

5.6.7.1 *General*

Exposed conductive parts shall be connected to a protective earthing conductor.

Simultaneously accessible exposed conductive parts shall be connected to the same earthing system individually, in groups or collectively.

5.6.7.2 *Arrangement*

A1

5.6.7.2.1 *General*

All submain and subcircuit protective earthing conductors shall be directly connected to the main earthing conductor or to another point on an earthing system that is connected to the main earthing conductor.

The connection shall be made at one or a combination of the following points:

(a) An earthing terminal/connection or bar at the main switchboard provided specifically for the connection of earthing conductors and which is directly connected to the main earthing conductor.

(b) Any point on the main earthing conductor.

(c) An earthing terminal/connection or bar at a distribution board provided specifically for the connection of protective earthing conductors and arranged in accordance with Clause 5.6.7.2.2.

(d) Any point on a protective earthing conductor providing facilities for earthing at a distribution board and arranged in accordance with Clause 5.6.7.2.2.

NOTE: Examples of earthing connections are shown in Figure 5.4.

A2 **5.6.7.2.2** *Restricted connections*

A1 The following restrictions apply to the use of protective earthing conductors:

(a) *Multicore cables* Any protective earthing conductor incorporated in the sheathing of a multicore cable with live conductors shall be used only for the earthing of electrical equipment, including the earthing contacts of socket-outlets, supplied through the associated live conductors.

(b) *Cables in conduit* Any protective earthing conductor laid-up with live conductors within a conduit run shall only be used for the earthing of electrical equipment, including the earthing contacts of socket-outlets, supplied through the associated live conductors.

5.6.7.3 *Protective earthing conductors at distribution boards*

A protective earthing conductor that originates at a distribution board in accordance with Clause 5.6.7.2(c) or (d) shall not be used for either the —

(a) earthing of electrical equipment which is supplied from another switchboard; or

(b) provision of earthing facilities for another distribution board.

The requirements of Item (b) need not apply where —

(i) earthing facilities for a distribution board originates from the same distribution board as the associated active conductors supplying the distribution board; or

(ii) a common protective earthing conductor is arranged to provide earthing facilities at a number of distribution boards as follows:

(A) The protective earthing conductor is connected to the main earthing conductor in accordance with Clause 5.6.7.2(a) or (b).

(B) The continuity of the protective earthing conductor is not dependent on a terminal at a distribution board.

(C) A direct connection is made between the common protective earthing conductor and any branch protective earthing conductor to a distribution board.

5.6.7.4 *Size (minimum cross-sectional area)*

5.6.7.4.1 *General*

The cross-sectional area of a protective earthing conductor shall ensure —

(a) adequate current-carrying capacity for prospective fault currents for a time at least equal to the operating time of the associated protective device; and

(b) appropriate fault-loop impedance (See Clauses 1.7.4.3.3 and 6.3.4.2); and

(c) adequate mechanical strength and resistance to external influences; and

(d) for parts of the protective earthing conductor that do not consist of cables, or parts of cables, that there is allowance for subsequent deterioration in conductivity that may reasonably be expected.

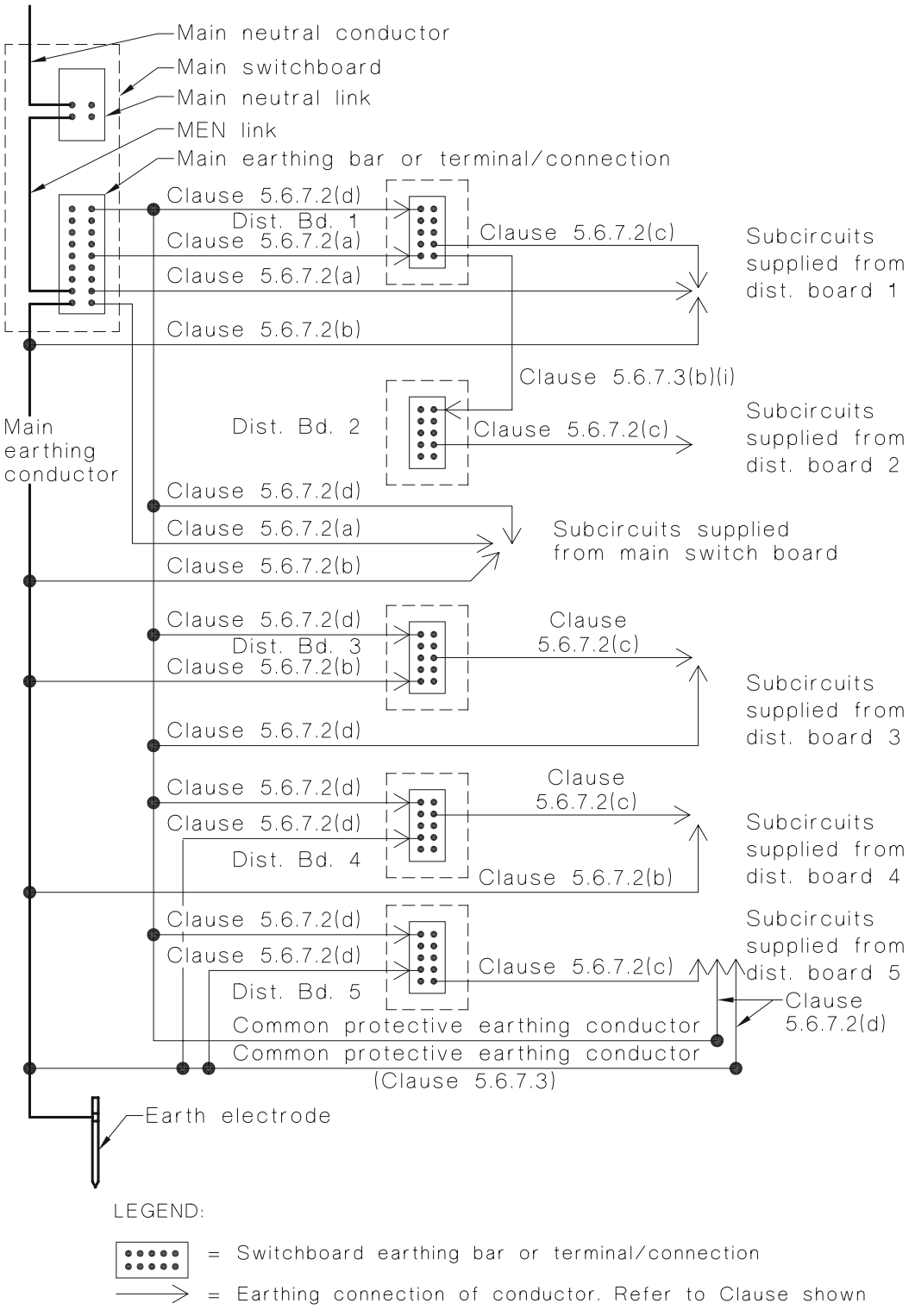
5.6.7.4.2 *Selection of cross-sectional area of protective earthing conductor*

The cross-sectional area of protective earthing conductors shall be either determined in accordance with Clause 5.5.1 or calculated in accordance with Clause 5.6.7.4.3, and shall be not less than the appropriate value shown in Table 5.1.

NOTES:

1 The installation should be so prepared that electrical equipment terminals are capable of accepting the protective earthing conductors.

2 Calculation in conformity with Clause 5.6.7.4.3 may be necessary if the choice of cross-sectional area of phase conductors has been determined by consideration of short-circuit current.



NOTE: Only one protective earthing connection is necessary.

FIGURE 5.4 DIAGRAMMATIC EXAMPLES OF ARRANGEMENT OF PROTECTIVE EARTHING CONDUCTORS (CLAUSES 5.6.7.2 AND 5.6.7.2.2)

5.6.7.4.3 *Calculation of cross-sectional area of protective earthing conductor*

The cross-sectional area shall be not less than the value determined by the following equation (applicable only for disconnection times not less than 0.1 s but not exceeding 5 s):

$$S = \sqrt{\left(\frac{I^2 t}{K^2}\right)} \qquad \ldots 5.6.7.4.3$$

where

S = cross-sectional area of protective earthing conductor, in square millimetres

I = the value of the fault current in amperes (for a.c. r.m.s. value) which would flow through the overcurrent protective device of the circuit concerned in the event of a short-circuit of negligible impedance

t = the disconnecting time of the overcurrent protective device in seconds, corresponding to the value of fault current I

K = factor dependent on the material of the protective earthing conductor, the insulation and other parts and the initial and the final temperatures

NOTES:

1 Values of K for protective earthing conductors in various conditions of service are given in the AS/NZS 3008.1. series, e.g. for copper conductors not laid up with other conductors, with PVC insulation K = 136, or for bare copper conductors K = 170.

2 Examples of the application of this equation are contained in the AS/NZS 3008.1 series.

If application of the equation produces non-standard sizes, conductors of the nearest higher standard cross-sectional area shall be used.

NOTE: Maximum permissible temperatures for joints should be considered (See the AS/NZS 3008.1 series).

5.6.7.5 *Types*

5.6.7.5.1 *General*

Protective earthing conductors may include the following:

(a) Earthing conductors which comply with Clause 5.5.2, separately installed.

(b) Earthing conductors which comply with Clause 5.5.2, in a common enclosure with live conductors.

(c) Earthing conductors in multi-core cables.

(d) Busbars.

(e) Metallic conduit, tube, pipe, trunking and similar wiring enclosures.

(f) Metallic sheaths, armours and screens of cables.

(g) Metallic framework used for mounting electrical equipment.

Sprinkler pipes or pipes conveying gas, water, flammable liquid or other metallic non-electrical services shall not be used as an earthing medium.

This requirement shall not preclude the bonding of such metallic non-electrical service enclosures to metallic electrical service enclosures in accordance with Clause 5.8.

5.6.7.5.2 *Special conditions*

The following conditions apply where the components in Clause 5.6.7.5.1(e), (f) or (g) are used as protective earthing conductors:

(a) *Metallic conduit, tube, pipe, trunking and similar wiring enclosures* If metallic wiring enclosures are used as a protective earthing conductor the following shall apply:

(i) The electrical equipment to be earthed shall be supplied by live conductors contained within the wiring enclosure.

(ii) If screwed metallic wiring enclosures are used to earth luminaires, rigid pendants and accessories such as switches and associated enclosures they shall be directly connected by metallic threads or locknuts.

(b) *Metallic sheaths, armours and screens of cables* The electrical equipment to be earthed shall be supplied by live conductors incorporated in the cable.

This requirement shall not preclude the use of a MIMS cable sheath as a main earthing conductor provided that any circuit protective earthing conductors connected to the sheath are associated only with the circuits supplied through the MIMS cable.

(c) *Metallic framework* The following shall apply:

(i) *General* The exposed conductive parts of electrical equipment mounted on metallic framework shall be earthed by the connection of a protective earthing conductor to the —

(A) exposed conductive part of the electrical equipment; or

(B) metallic framework or electrical equipment support structure which is in effective electrical contact with the exposed conductive part.

(ii) *Contact with hinged components* The exposed metal of electrical equipment in effective electrical contact with hinged components of metallic framework, such as cubicle doors, shall be deemed to be earthed provided that —

(A) the fixed component of the framework is connected to a protective earthing conductor; and

(B) the fixed and hinged components of the framework are connected by means of a flexible protective earthing conductor.

A3 (iii) *Contact with moving components* The exposed conductive parts of electrical equipment in effective electrical contact with moving components shall be deemed to be earthed provided that—

(A) the fixed component of the equipment is connected to a protective earthing conductor; and

(B) the fixed and movable components of the equipment are in effective contact by means of metal-to-metal bearing surfaces, such as the contact between a rail and wheel or between an axle and bearing.

Additional means of electrical continuity, such as sliding shoes or spring-loaded brushes, may be required where an accumulation of rust or non-conductive dust is likely to occur.

5.6.7.6 *Insulation and identification*

Where protective earthing conductors are comprised of cables they shall be insulated and identified in accordance with Clause 5.5.3.

5.6.7.7 *Continuity*

5.6.7.7.1 *General*

Protective earthing conductors shall be suitably protected against mechanical and chemical deterioration and electrodynamic forces.

Star or cutting washers or similar devices which effectively cut through paint or similar coatings are considered to be an acceptable method of ensuring earth continuity across bolted or clamped joints between metal equipment panels or framework which have painted or coated surfaces.

5.6.7.7.2 *Metallic wiring enclosures*

Metallic wiring enclosures and associated fittings that require to be earthed, including those used as an earthing medium, shall be mechanically and electrically continuous.

The resistance of such a wiring enclosure earthing arrangement shall be in accordance with Clause 5.4.3.

5.6.7.7.3 *Metallic sheaths, armours and screens of cables*

Metallic sheaths, armours and screens of cables and associated fittings that require to be earthed, including those used as an earthing medium, shall be mechanically and electrically continuous.

The resistance of such cable components and associated fittings providing earth continuity shall be in accordance with Clause 5.4.3 or, where used as an earthing medium, in accordance with that required for a copper earthing conductor determined in accordance with Clause 5.5.1.

5.6.7.7.4 *Connecting devices*

Where electrical equipment is connected to the fixed wiring by a connection in the form of a plug and socket-outlet, appliance plug or similar connecting device, any connection of exposed conductive parts to earth shall be —

(a) made automatically, before the live connections are made, when any plug portion is inserted in the corresponding socket-outlet; and

(b) broken automatically, not before the live connections are broken, when any plug portion is withdrawn from the corresponding socket-outlet.

5.6.7.8 *Installation*

Protective earthing conductors shall be installed in accordance with Clause 5.5.4.

5.6.7.9 *Connections*

Connections in protective earthing conductors shall comply with Clause 3.7.

5.7 EARTHING OF ELECTRICAL EQUIPMENT

5.7.1 General

Except where exempted by the provisions of Clause 5.7.2, any exposed conductive parts of electrical equipment shall be earthed in accordance with the requirements of Clauses 5.4.1 and 5.4.2.

5.7.2 Exceptions — Special situations

Where the wiring of electrical equipment complies with any of the following provisions the electrical equipment need not be earthed:

(a) Double insulation The following applies:

(i) General Electrical equipment complying with AS/NZS 3100 for double insulation need not be earthed.

(ii) External electrical equipment wiring Where cables connecting electrical equipment having double insulation enter the electrical equipment in such a manner that they may come into contact with accessible external conductive parts of the electrical equipment, the cables shall be of a type affording double insulation.

(iii) Internal electrical equipment wiring Conductors within electrical equipment having double insulation shall be protected, secured or insulated so that, if any one conductor becomes detached from its termination, neither the conductor nor its functional insulation can come into contact with accessible metal. The attachment of one conductor to another by tying, lacing, clipping or the like, in such a manner as to prevent either conductor coming into contact with accessible conductive parts if it becomes detached from its termination, shall be deemed to comply with this requirement.

(b) Protection by electrical separation Exposed conductive parts are not earthed for electrical equipment supplied in accordance with Clause 1.7.4.5.