

SECTION 2

GENERAL ARRANGEMENT, CONTROL AND PROTECTION

# GENERAL

* + 1. **Application**

**This Section specifies the minimum requirements for the selection and installation of switchgear and controlgear that shall be achieved to satisfy Part 1 of this Standard.**

* + 1. **Selection and installation**

**Switchgear and controlgear shall be selected and installed to perform the following functions or have the following features:**

1. **Provide control or isolation of the electric al installation, circuits or individual items of apparatus as required for maintenance, testing, fault detection or repair.**
2. **Enable automatic disconnection of supply in the event of an overload, short-circuit or excess earth leakage current in the protected part of the electrical installation.**
3. **Provide protection of the electrical installation against failure from overvoltage or undervoltage conditions.**
4. **Provide for switchgear and controlgear to be grouped and interconnected on switchboards, enclosed against external influences, and located in accessible positions.**
5. **Separately control and protect the circuit arrangements without affecting the reliability of supply to, or failure of, other parts of the installation.**

* **(f) Installed in accordance with the requirements of this Section, and the additional requirements as specified in the manufacturer’s instructions.**

The operating characteristics of switchgear, controlgear and switchboards that shall be considered include voltage rating, current rating, frequency, temperature rise, duty, and fault level.

# ARRANGEMENT OF ELECTRICAL INSTALLATION

## Circuits

* + - 1. *General*

**The electrical installation shall be arranged into an appropriate number of separate circuits taking the following into account:**

1. **The relationship of the equipment, including any requirement for operation as a group and any special need identified by the user.**
2. **The load and operating characteristics of the equipment in relation to the rating of the circuit components.**
3. **The limitation of consequences of circuit failure including loss of supply to critical equipment, overload and the ability to locate a fault.**
4. **The facility for maintenance work, and capacity for alterations and additions, to be performed without interrupting supply to other parts of the installation.**

* NOTE: Specific design and equipment may need to be considered to ensure the continuity of supply. For further guidance, refer to Appendix M.

## Circuits for safety services shall be separate from those used to supply the remainder of the electrical installation, as required by Clause 7.2.2.

NOTES:

1. The most common distribution arrangement for a low voltage electrical installation is radial branched distribution, an example of which is shown in Figure B1 (Appendix B).
2. Division of circuits falls logically into several categories, each an individual circuit or group of circuits. Typically, the circuit groups selected are as follows:
   1. Lighting.
   2. Socket-outlets.
   3. Heating and/or airconditioning appliances.
   4. Motor-driven plant.
   5. Auxiliary services, such as indication and control.
   6. Safety services.
3. Appendix C provides guidance on circuit arrangements for basic applications.
   * + 1. *Origin of submains and final subcircuits*

* Every submain and every final subcircuit shall commence at a main switchboard or at a distribution switchboard.
* All conductors of a submain or a final subcircuit shall be connected at the one switchboard.
  + - 1. *Common neutral*

## Each single-phase circuit, and each multiphase circuit that requires a neutral conductor for the operation of connected equipment, shall incorporate a neutral conductor.

A common neutral conductor may be used for two or more circuits originating from the same supply subject to the following conditions:

1. The continuity of the common neutral conductor shall not depend on connections at the terminals of electrical equipment, including control switches.
2. Final subcircuits that contain a common neutral shall be controlled and protected by linked circuit-breakers or linked switches.
3. The neutral conductor shall be marked at switchboards to identify the associated active conductors in accordance with Clause 2.10.5.5.
4. Alternative sources of supply to a single appliance (such as a water heater, space heater or airconditioner) shall have a common isolating switch.

NOTES:

1. Typical applications for common neutrals include groups of single-phase lights arranged across multiphase supply, and separate components of a single-phase appliance, such as a cooking unit.
2. Looping of a common neutral conductor at terminals of equipment supplied from different circuits may cause the load side neutral conductor potential to rise to full line voltage and create a dangerous live situation when disconnected for repair or replacement of the equipment.
3. This Clause does not preclude connection of a common neutral in a junction box.

The current-carrying capacity of a common neutral shall be determined from the current-carrying capacity of the associated active conductors in accordance with Clause 3.5.2.

* + - 1. *Electric vehicle charging circuits*
* NOTES:
  1. Guidance for installations for electric vehicle charging circuits is provided in Appendix P.
  2. In New Zealand only, requirements for circuits supplying electric vehicle charging are in Clause 7.9.

## Maximum demand

**The maximum demand in consumer mains, submains and final subcircuits, taking account of the physical distribution and intended usage of electrical equipment in the electrical installation and the manner in which the present requirements might vary, shall be determined using one of the methods set out in Items (a) to (d).**

If the actual measured maximum demand is found to exceed that obtained by calculation or assessment, the measured value shall be deemed to be the maximum demand.

1. *Calculation* The maximum demand may be calculated in accordance with the guidance given in this Standard for the appropriate type of electrical installation and electrical equipment supplied.

NOTE: Guidance on the determination of maximum demand is provided for basic electrical installations in Appendix C.

It is recognized that there may be considerable differences in loading from one electrical installation to another. Alternative methods of calculating the maximum demand may be used taking account of all

the relevant information available for any particular electrical installation.

1. *Assessment* The maximum demand may be assessed where—
   1. the electrical equipment operates under conditions of fluctuating or intermittent loading, or a definite duty cycle;
   2. the electrical installation is large and complex; or
   3. special types of occupancy exist.
2. *Measurement* The maximum demand may be determined by the highest rate of consumption of electricity recorded or sustained over a period of 30 minutes when demand is at its highest by a maximum demand indicator or recorder.
3. *Limitation* The maximum demand may be determined by the current rating of a fixed setting circuit-breaker, or by the load setting of an adjustable circuit-breaker.

The maximum demand of consumer mains and submains may be determined by the sum of the current settings of the circuit-breakers protecting the associated final subcircuit/s and any further submain/s.

## Selection and installation of conductors

Conductors shall be selected and installed in accordance with the provisions of Section 3.

## Operating characteristics of equipment

* + - 1. *General*

Every item of electrical equipment shall be selected and installed so as to ensure compliance with the following clauses and the relevant clauses in other sections of this Standard.

A device with more than one function shall comply with all the requirements of this Section appropriate to each separate function.

* + - 1. *Voltage*

The voltage rating of electrical equipment shall be suitable for the nominal voltage of the circuit to which it is connected.

* + - 1. *Current*

Each item of electrical equipment shall be selected and installed to be suitable for—

1. the design current, taking into account any capacitive, inductive and harmonic effects; and
2. the current likely to flow in abnormal conditions for such periods of time as are determined by the characteristics of the protective devices concerned.
   * + 1. *Frequency*

If frequency has an influence on the characteristics of electrical equipment, the rated frequency of electrical equipment shall correspond to the nominal frequency of the supply to the circuit concerned.

* + - 1. *Power*

Each item of electrical equipment selected on the basis of its power characteristics shall be suitable for the duty demanded of the electrical equipment.

* + - 1. *Effects on operator or other equipment*

Each item of electrical equipment shall be selected and installed so that, providing it is maintained, it will not cause harm to an operator or harmful effects to other equipment, or impair the supply during normal service, including switching operations.

NOTE: This provision may restrict the use of electrical equipment that relies on the training of the operator for the safe and correct use of the electrical equipment.

# CONTROL OF ELECTRICAL INSTALLATION

## General

**Electrical installations shall be provided with devices to prevent or remove hazards associated with the electrical installation and for maintenance of electrically activated equipment.**

NOTE: The measures specified in this Clause (Clause 2.3) are in addition to, and not alternatives to, the protective measures specified in Clause 2.4.

Electrical installations shall include all switching devices or other means of disconnection necessary to enable operations, repairs and maintenance work to be carried out safely.

Any device provided shall comply with the relevant requirements of this Clause (Clause 2.3), in accordance with the intended function or functions.

Such devices are classified according to one of the following functions:

1. Isolation, in accordance with Clause 2.3.2.2.
2. Emergency, in accordance with Clause 2.3.5.2.
3. Mechanical maintenance, in accordance with Clause 2.3.6.2.
4. Functional (control), in accordance with Clause 2.3.7.2.

Where two or more such functions are performed by a common device, that device shall comply with all the requirements for each of the functions concerned.

## Common control requirements

* + - 1. *General*

\* **2.3.2.1.1** *All systems*

Every circuit shall be capable of being isolated from each of the supply conductors, in accordance with Clause 2.3.2.1.2 or 2.3.2.1.3, as appropriate.

Provided that the service conditions allow it, and the appropriate safety measures are maintained, a group of circuits may be isolated by a common switch.

Provision shall be made to enable isolation of electrical equipment and to prevent electrical equipment from being inadvertently energized. The means of isolation shall be such that a deliberate action in addition to the normal method of operation is required to energize the circuit.

NOTE: Such precautions may include one or more of the following measures:

1. Provision for the fitting of a padlock.
2. Warning tags or notices.
3. Location within a lockable space or enclosure.
4. Short-circuiting and earthing may be used as a supplementary measure only.

Where an item of equipment or enclosure contains live parts connected to more than one supply, a notice shall be placed in such a position that any person gaining access to live parts will be warned of the need to isolate those parts from the various supplies.

*Exception: A notice need not be provided where an interlocking arrangement is provided or the live parts are suitably shrouded to ensure that all the circuits concerned are isolated.*

Where relevant, suitable means shall be provided for the discharge of stored electrical energy (see Clause 4.15.3).

* **2.3.2.1.2** *Alternating current systems*

Provisions for isolation of conductors in a.c. systems are as follows:

* 1. *Active conductors* All active conductors of an a.c. circuit shall be capable of being isolated by a device for isolation.
  2. *Neutral conductor:*
     1. No switch or circuit-breaker shall be inserted in the neutral conductor—
        1. of consumer mains; or
        2. where the neutral conductor is used as a combined protective earthing and neutral (PEN) conductor for protective earthing of any portion of an electrical installation.

NOTE: This requirement applies to situations such as an earth sheath return (ESR) system or a submain neutral used for earthing of an electrical installation in an outbuilding in accordance with Clause 5.5.3.1.

* + 1. A switch or circuit-breaker may operate in the neutral conductor of circuits other than those in Item (i) where—
       1. the neutral pole of a multi-pole switch or circuit-breaker, having an appropriate short-circuit breaking and making capacity, is linked and arranged to switch substantially together with all active poles; or
       2. the switch or circuit-breaker is linked with corresponding switches so that the neutral contact cannot remain open when the active contacts are closed.

A switched neutral pole shall not open before and shall not close after the active pole(s).

* + 1. Where an item of switchgear is required to disconnect all live conductors of a circuit, it shall be of a type such that the neutral conductor cannot be disconnected or reconnected without the respective active conductors also being disconnected or reconnected.

NOTE: The manual disconnection and connection of neutral conductors should be as follows:

\*

1. The active conductors should be disconnected before the neutral conductors.
2. The neutral conductors should be connected before the active conductors.

Refer to AS/NZS 4836 for safe work practices.

* + 1. A switch in the control circuit of a fire pump shall operate in the neutral conductor in accordance with Clause 7.2.5.6.4.

In accordance with Clause 2.5.1.1, no fuse shall be inserted in a neutral conductor.

* 1. *Switching of earthing conductor prohibited* An earthing conductor shall not be isolated or switched.

A conductor used as a combined protective earthing and neutral (PEN) conductor shall not be isolated or switched.

**2.3.2.1.3** *Direct current systems*

\* All conductors of a d.c. circuit shall be capable of being isolated by a device for isolation.

NOTE: Guidance is provided in Appendix Q on the installation of d.c. systems.

*Exceptions:*

1. *In the case of a d.c. circuit having one conductor connected either to earth or to a protective earthing conductor, that conductor need not be isolated or switched.*
2. *In accordance with Clause 7.5.8.2(b), switches in an extra-low voltage*

*d.c. electrical installation may operate in one less conductor than the number of conductors in the circuit.*

* + - 1. *Devices for isolation*
         1. *General*
* Devices for isolation shall effectively isolate all active conductors from the circuit.

A semiconductor (solid-state) device shall not be used for isolation purposes.

A device for isolation—

* 1. shall be capable of withstanding an impulse voltage likely to occur at the point of installation, or shall have an appropriate contact gap;
  2. shall not be able to falsely indicate that the contacts are open;
  3. shall clearly and reliably indicate the isolating position of the device;

NOTE: The symbols ‘O’ (OFF) and ‘I’ (ON) are deemed to satisfy this requirement.

* 1. shall be designed and installed so as to prevent unintentional closure, such as might be caused by impact, vibration or the like;
  2. shall be a device that disconnects all active conductors of the relevant supply; and

NOTE: Single-pole devices situated adjacent to one another may be used.

* 1. shall be readily available.

Where a device for isolation is not capable of interrupting normal load current, suitable measures shall be taken to prevent it operating while carrying current.

NOTE: Such measures may include interlocking with an associated circuit- breaker or, where the device will only be operated by authorized persons, suitable warning notices.

Where a device for isolation is a switching device it shall be capable of being secured in the open position.

NOTE: Isolation may be achieved by means such as switch-disconnectors (switch isolators) or, where switching is not required, by—

* + 1. multi-pole or single-pole disconnectors (off load isolators);
    2. plugs and socket-outlets;
    3. fuses;
    4. links; or
    5. special terminals that do not require the removal of a conductor.
       - 1. *Identification*

All devices used for isolation shall be clearly identified to indicate the circuit or equipment that they isolate.

NOTE: This may be achieved by marking or, in the case of isolation of a single item of equipment, location of the device.

A switch that is marked with the following symbol, in accordance with the relevant Standard, is deemed to be suitable for isolation:

Relevant product Standards with requirements and tests for isolation include AS/NZS 3111, AS/NZS 3133, AS/NZS IEC 60947.2,

AS/NZS IEC 60947.3, AS/NZS 60898.1, AS/NZS 61008.1 and

AS/NZS 61009.1.

NOTE: Symbols used in this Standard are listed in Appendix J.

## Main switches

* **2.3.3.1** *Introduction*

The following requirements are intended to provide for the—

* 1. efficient and effective isolation of electricity supply from the electrical installation, or part thereof, by persons, including emergency services personnel, in the event of an emergency arising that requires prompt isolation; and
  2. maintenance of supply to safety services during an emergency that may require, or result in, isolation of supply from other portions of the electrical installation.
     + 1. *General*

## The supply to every electrical installation shall be controlled on the main switchboard by a main switch or switches that control the whole of the electrical installation.

Where multiple supplies are provided, each supply shall be controlled by a main switch or switches on the main switchboard for each supply.

* *Exception: Main switches for alternative or supplementary supplies may be located at any switchboard within the installation, provided they are installed in accordance with an applicable standard, for example, AS/NZS 3010 or AS/NZS 4777.1.*

Each part of an electrical installation supplying a safety service in accordance with Clause 7.2 shall be controlled by a main switch or switches, separate from those used to control the remainder of the electrical installation, as required by Clause 7.2.3.

Every main switch shall satisfy the requirements of Clause 2.3.2.2 for isolating devices.

Main switches shall be located, arranged and legibly and permanently identified, in accordance with Clauses 2.3.3.3 to 2.3.3.5, to allow for their effective operation in an emergency.

*Exceptions: The following need not be controlled by a main switch:*

1. *Consumer mains.*
2. *Equipment installed as required by an electricity distributor for service protection, control or electricity consumption metering purposes.*
3. *Ancillary equipment, measuring devices and associated wiring that is required to be connected to the supply side of the main switch or switches, provided that this wiring and equipment is confined within or on the switchboard.*
4. *Equipment, such as voltage sensing equipment, associated with a safety service that is connected on the supply side of a main switch, in accordance with Clause 7.2.*
5. *Equipment, such as voltage sensing equipment, associated with an alternative supply system that is connected on the supply side of a main switch, in accordance with Clause 7.3.*
6. *Fault-current limiters.*
7. *Surge diverters installed to protect consumer mains or main switchboards.*
   * + 1. *Number of main switches*

The number of main switches shall be kept to the minimum practicable to provide for effective operation in an emergency.

Domestic electrical installations, including each separate domestic electrical installation forming part of a multiple electrical installation, shall be provided with not more than one main switch for—

1. each separately metered supply; or
2. where there is more than one separately controlled supply from a meter, a main switch for each of the separately controlled supplies.

* **2.3.3.4** *Location and operation*

Main switches shall be accessible as follows:

* 1. *General* Main switches shall be readily accessible and the means of operating such switches shall be not more than two metres above the ground, floor or a suitable platform.

*Exception: A main switch need not be located on a switchboard nor be readily accessible where unauthorized operation may impair safety and the electrical installation is—*

* + 1. *located on public land; and*
    2. *associated with telephone cabinets, traffic control signals and street furniture, such as bus shelters, and the like; and*
    3. *otherwise controlled and protected in accordance with the requirements of this Standard.*
* (b) *Operating handles or controls* associated with a main switch shall be manually operated, single action and mechanical. They shall consist of a handle, lever, push-buttons or similar device. Electronic touch screens, programmable control systems or the like shall not be used as a means of operating main switches.

Electronic touch screens may be used for remote control of main switch/s as per Clause 2.3.3.6.

1. *Electrical installations with more than one occupier* Each individual occupier shall have readily available access to an isolating switch or switches that isolate that occupier’s portion of the electrical installation.

The isolating switch or switches need not control the submains supplying that portion of the electrical installation but shall be mounted on a switchboard located either in the individual portion of the electrical installation or within easy access from an entrance to the individual premises.

The number of such switches shall be in accordance with Clause 2.3.3.3 for main switches.

*Exception: This requirement need not apply where the main switch or switches for the electrical installation are readily accessible to the individual occupier.*

* + - 1. *Identification*

Main switches shall be identified as follows:

1. Each main switch shall be marked ‘MAIN SWITCH’ and shall be readily distinguishable from other switchgear by means of grouping, contrasting colouring or other suitable means to provide for prompt operation in an emergency.
2. Where there is more than one main switch, each main switch shall be marked to indicate the electrical installation or portion of the electrical installation it controls.
3. Where the opening of a main switch brings into operation or isolates an alternative supply, a notice shall be provided to indicate the position of the main switch controlling the alternative supply.
4. Where supply is provided at more than one point in any building, a prominent notice shall be provided at each main switchboard, indicating the presence of other supplies and the location of other main switchboards.

* (e) Main switches for supplementary or alternative supplies shall be labelled to indicate the energy source.

NOTE: Marking requirements for other switches are contained in Clause 2.3.4.4.

* + - 1. *Remote control*

Where provision is made for remote control of the main switch or switches, the following applies:

1. Remote control facilities shall be located and identified in accordance with Clauses 2.3.3.4, 2.3.3.5 and 2.10.2.4.
2. Operation of remote control facilities shall cause the main switch to isolate supply to the associated parts of the installation.
3. Where remote control facilities also provide the capability for a main switch to be closed—
   1. the facilities shall be designed, arranged and installed to prevent inadvertent closing because of a fault or malfunction in the control circuit wiring or auxiliaries;
   2. the main switch shall have facility for a suitable device to enable it to be locked in the open position, in accordance with Clause 2.3.2.2; and

* (iii) shall not be capable of being overridden or bypassed by programmable control systems or the like.

Where provision is made for remote control of general installation main switches, remote control facilities need not be provided for separate main switches supplying safety services, in accordance with Clause 7.2.

* (d) Where an electronic touch screen, programmable control system or the like is used for the remote control of a main switch(es), the requirements for main switches in Clause 2.3.3.4(b) shall apply.

## Additional isolating switches

* + - 1. *Electrical installation in an outbuilding*

An electrical installation in an outbuilding shall comply with the following:

1. *General* An electrical installation in an outbuilding shall be treated as a separate electrical installation if it—
   1. has a maximum demand of 100 A or more per phase; and
   2. is provided with a switchboard.
2. *Main switches*:
   1. *General* A main or isolating switch or switches shall be installed on the switchboard in the outbuilding to control the electrical installation in the outbuilding.
   2. *Supply by more than one submain* Where the electrical installation in the outbuilding is supplied through more than one submain, the supply through each such submain shall be controlled by a main switch or switches, in accordance with Item (b)(i).

The main switch or switches associated with each submain need not be mounted on the same switchboard as those associated with other submains, provided that the location of all other main switches within the outbuilding is indicated on a prominent and indelible notice adjacent to each main switch or group of switches.

* + - 1. *Submains and final subcircuits greater than 100 A*

Every submain and final subcircuit having a rating exceeding 100 A per phase shall be controlled by a separate isolating switch on the switchboard at which the circuit originates.

*Exception: This requirement need not apply where fault-current limiters or fuses protect small submains that are teed off larger submains, e.g. teeing off large rising submains at each floor.*

* + - 1. *Alternative supply*

Where an electrical installation, or part thereof, is provided with an alternative supply in accordance with Clause 7.3, an isolating switch shall be provided at the source of supply or at a switchboard, in accordance with Clause 7.3.

* + - 1. *Identification*

Isolating switches required by this Clause (Clause 2.3.4) shall be legibly and permanently identified, e.g. by marking, to indicate the circuits that they isolate.

Where, for functional reasons, a circuit for the control of an isolating device cannot be isolated in a distribution board or a switchgear assembly, a warning notice with suitable wording shall be affixed to that board or assembly.

Where the operation of a switch automatically brings into service an alternative supply, the purpose of the switch shall be marked accordingly.

* + - 1. *Appliances and accessories*

Appliances and accessories, including motors, shall be provided with devices for isolation and switching, in accordance with relevant clauses of Sections 4 and 7.

These clauses include the following:

|  |  |  |
| --- | --- | --- |
| (a) | Socket-outlets .....................................................................................Clause 4.4. | |
| (b) | Cooking appliances ...........................................................................Clause 4.7. | |
| (c) | Water heaters Clause | 4.8. |
| (d) | Room heaters .....................................................................................Clause 4.9. | |
| (e) | Electric heating cables for floors and ceilings  and trace heating appliances Clause | 4.10. |
| (f) | Electricity converters Clause | 4.12. |
| (g) | Motors Clause | 4.13. |
| (h) | Capacitors Clause | 4.15. |
| \* (i) | Gas appliances and equipment Clause | 4.18. |
| (j) | Airconditioners Clause | 4.19. |
| (k) | Lifts Clause | 4.20. |

1. Safety services ...................................................................................Clause 7.2.
2. Electricity generation systems .......................................................Clause 7.3.

## Emergency switching including emergency stopping

* + - 1. *General*

## Means shall be provided for emergency switching of any part of an electrical installation where it may be necessary to control the supply to remove an unexpected danger.

\* Where required, because of the risk of electric shock, the emergency switching device shall be an isolating device.

The arrangement of the emergency switching shall be such that its operation does not introduce a further danger or interfere adversely with the complete operation necessary to remove the danger.

NOTES:

1. Emergency switching may require switching OFF or switching ON.
2. Examples of electrical installations where means for emergency switching are used are as follows:
   1. Machinery.
   2. Conveyors.
   3. Groups of machines.
   4. Pumping facilities for flammable liquids.
   5. Ventilation systems.
   6. Certain large buildings, e.g. department stores.
   7. Electrical testing and research facilities.
   8. Boiler rooms.
   9. Large kitchens.
   10. Teaching laboratories.
   11. High-voltage discharge lighting, e.g. neon signs.
       * 1. *Emergency switching devices*

Means for emergency switching shall consist of—

1. a single switching device directly interrupting the incoming supply; or
2. a combination of several items of electrical equipment operated by one single action resulting in the removal of the hazard by interrupting the appropriate supply.

*Exception: Emergency stopping may include the retention of supply for electric braking facilities.*

* Devices for emergency switching shall—
  1. be capable of breaking the full-load current of the relevant parts of the electrical installation, taking account of stalled motor currents where appropriate; and
  2. be manually operated directly interrupting the main circuit, where practicable. A device, such as a circuit-breaker or a contactor operated by remote control, shall open on de-energization of the coil, or another technique of suitable reliability shall be employed; and
  3. be provided with means of operation capable of latching or being restrained in the ‘OFF’ or ‘STOP’ position; and
  4. not re-energize the relevant part of the electrical installation upon release of the device; and
  5. where danger is likely to occur, require manual reset before the electrical equipment can be started.

Plugs and socket-outlets shall not be provided for use as a means for emergency switching.

*Exception: Where electrical equipment is energized from a socket-outlet, a switch associated with the socket-outlet may be used for emergency switching.*

* + - 1. *Installation*

Devices for emergency switching, including stopping, shall be so placed as to be readily accessible and identifiable at places where danger might occur, and at any additional remote position from which a device may need to be operated in the case of emergency.

* + - 1. *Identification*

Devices for emergency switching, including emergency stopping, shall be so placed and marked as to be readily identifiable and convenient for their intended use.

The means of operating these devices, such as handles or push-buttons for emergency switching, shall be legibly and permanently identified and coloured red with a contrasting background.

*Exception: A lanyard, chain or rope used to provide a facility for remote operation of an emergency stopping device need not be coloured red, e.g. a lanyard above a conveyor.*

## Shutting down for mechanical maintenance

* + - 1. *General*

## Means of disconnecting electricity supply (shutting down) shall be provided where mechanical maintenance of electrically powered equipment might involve a risk of physical injury.

NOTES:

1. Such injuries include burns and those caused by radiated heat and unexpected mechanical movements.
2. Electrically powered mechanical equipment may include rotating machines, heating elements and electromagnetic equipment.
3. Examples of electrical installations where means of shutting down for mechanical maintenance are used include cranes, lifts, escalators, conveyors, machine tools and pumps.
4. Systems powered by other means, e.g. pneumatic, hydraulic or steam, are not within the scope of this Clause. In such cases, shutting down any associated supply of electricity may not be sufficient to ensure safety.

Suitable means, such as facilities for locking the means of shutting down in the open position, the enclosure of the means of shutting down in a lockable enclosure or facilities for the attachment of a warning notice or notices, shall be provided to prevent operation of the means of shutting down and electrically powered equipment from being inadvertently started during mechanical maintenance.

*Exception: Locking facilities or a lockable enclosure need not be provided where the means of shutting down is continuously under the control of the person performing such maintenance.*

* + - 1. *Devices for shutting down*

Devices for shutting down for mechanical maintenance shall—

1. require manual operation; and
2. clearly and reliably indicate the ‘OFF’ position; and
3. be designed or installed so as to prevent unintentional closure.

NOTE: Such closure might be caused by impact, vibration or the like.

* + - 1. *Installation*

Devices for shutting down for mechanical maintenance shall be inserted in the main circuit.

Where switches are provided for this purpose, they shall be capable of interrupting the full-load current of the relevant part of the electrical installation. They need not interrupt all live conductors.

*Exception: Interruption of the control circuit of a drive or the like may occur where—*

1. *supplementary safeguards, such as mechanical restrainers are provided; or*
2. *direct interruption of the main supply is achieved by another means.*

NOTE: Shutting down for mechanical maintenance may be achieved by devices, such as switches, circuit-breakers or plugs and sockets.

A device located remotely from the electrical equipment it controls, which is used for shutting down for mechanical maintenance, shall be provided with facilities for securing it in the open position.

* + - 1. *Identification*

Devices for shutting down for mechanical maintenance shall be placed and marked so as to be readily identifiable and convenient for their intended use.

## Functional (control) switching

* + - 1. *General*

Functional switching may be used where switching of electrical equipment, or part of an electrical installation, is required for operational control only and not for safety reasons.

NOTE: Functional switching devices may be switches, semiconductor (solid-state) devices, or contactors.

A functional switching device shall be provided for each part of a circuit or item of apparatus that may be required to be controlled independently of other parts of the electrical installation or apparatus.

A single functional switching device may control several items of apparatus intended to operate simultaneously.

NOTE: The switching device may form part of the apparatus.

* + - 1. *Functional switching devices*

Disconnectors, fuses or links shall not be used for functional switching.

Functional switching devices shall be suitable for the most onerous of the duties that they might be required to perform.

NOTE: The type of loading, the frequency of operation, and the anticipated number of operations should be taken into account when assessing the most onerous duty. (Systems of duty classification are found in the Standards relevant to the electrical equipment concerned, or in the switch manufacturer’s information.)

Functional switching devices need not switch all live conductors of a circuit.

Functional switching devices controlling loads having a significantly low power factor, such as motors or fluorescent lighting, shall be subject to an appropriate de-rating factor.

*Exception: No de-rating factor need apply where the device has been designed for the purpose, e.g. switches having a utilization category of AC23A in accordance with AS/NZS IEC 60947.3, used to control circuits of fluorescent lighting are deemed to be designed for the purpose.*

* + - 1. *Identification*

Functional switching devices need not be identified to indicate the ‘ON’ or ‘OFF’ position.

*Exception: Appliance switches shall be identified to include the ‘OFF’ position, in accordance with AS/NZS 61058.1.*

* + - 1. *Control circuits*

Control circuits shall be designed, arranged and protected to limit dangers resulting from a fault between the control circuit and other conductive parts liable to cause malfunction, e.g. inadvertent operations of the controlled apparatus.

# FAULT PROTECTION

## General

The following methods of fault protection are recognized in this Standard:

\* (a) Automatic disconnection of supply, in accordance with Clause 1.5.5.3 and Clause 5.7.

1. The use of Class II equipment or equivalent insulation, in accordance with Clause 1.5.5.4.
2. Electrical separation, in accordance with Clauses 1.5.5.5 and 7.4.

The requirements for protection by means of automatic disconnection of supply are set out in Clauses 2.4.2, 2.4.3, 2.5 and 2.6.

## Protection by automatic disconnection of supply

Protection by means of automatic disconnection of supply is intended to limit the prospective touch voltage arising between simultaneously accessible conductive parts in the event of a fault between a live part and exposed conductive parts or a protective earthing conductor.

This protection shall be achieved by—

1. provision of a system of earthing in which exposed conductive parts are connected to a protective earthing conductor, in accordance with Section 5; and
2. disconnection of the fault by an overcurrent protective device or an RCD.

## Types of devices

A device used for protection by automatic disconnection of supply shall not be capable of automatically re-closing. The following types of devices may be employed to provide automatic disconnection of supply:

1. Enclosed fuse-links complying with the appropriate part(s) of the IEC 60269 series.
2. Miniature overcurrent circuit-breakers complying with AS/NZS 60898 series or AS/NZS 3111.
3. Moulded-case circuit-breakers complying with AS/NZS IEC 60947.2.
4. Fixed setting RCDs complying with AS/NZS 3190, AS/NZS 61008.1 or AS/NZS 61009.1.
5. Other devices, with no automatic reclose function, having characteristics similar to any of the devices listed in Items (a) to (d).

Semi-enclosed rewireable fuses shall not be used.

*Exception: Devices with an automatic reclose function of the type that automatically verifies the insulation is satisfactory before the device recloses are permitted.*

## Auto-reclose devices

A device may be of the auto-reclose type provided that the following conditions are met:

1. The device shall not be installed to meet the requirements of Clause 1.5.6.
2. The automatic reclose function cannot be engaged after manually switching off.
3. A warning notice is clearly displayed indicating that the automatic reclose function of the device must be disengaged, the device manually switched off, and the requirements of Clause 2.3.2 applied before performing any work on the electrical installation.
4. There is a time delay before the first automatic reclose (e.g. 3 min).
5. The number of reclosing operations is limited (e.g. to 3).

*Exception: Item (a) need not apply if the device is of a type that automatically verifies the insulation is satisfactory before the device recloses.*

# PROTECTION AGAINST OVERCURRENT

## General

\* **2.5.1.1** *General requirements*

## Active conductors shall be protected by one or more devices that automatically disconnect the supply in the event of overcurrent,

**before such overcurrent attains a magnitude or duration that could cause injury to persons or livestock or damage because of excessive temperatures or electromechanical stresses in the electrical installation.**

No fuse shall be inserted in a neutral conductor. Protective devices that incorporate a switching function in the neutral conductor shall comply with the requirements of Clause 2.3.2.1.2(b).

Protection against overcurrent shall consist of protection against—

1. overload current, in accordance with Clauses 2.5.2 and 2.5.3; and
2. short-circuit current, in accordance with Clauses 2.5.2 and 2.5.4.

Protection against overload current and short-circuit current shall be coordinated, in accordance with Clause 2.5.6.

NOTES:

1. Overcurrent protection is inseparably linked to the current-carrying capacity and temperature limits of the protected cable.

* Reduction in current-carrying capacity of conductors may occur by a change in cross-sectional area, method of installation, or type of cable or conductor.

1. Appendix I provides guidance on the ratings of overload protective devices where alterations or repairs involve the use of existing imperial conductors.
   * + 1. *Consumer mains*

* Overcurrent protection of consumer mains shall be arranged in accordance with one of the following:
  1. Short-circuit protection and overload protection shall be provided at the origin of the consumer mains (the point of supply) (see Notes 1 and 2).
  2. Short-circuit protection shall be provided at the origin of the consumer mains and overload protection shall be provided at the main switchboard (see Notes 1, 3, and 4.)
  3. Short-circuit protection need not be provided where overload protection is provided at the main switchboard and the consumer mains are constructed and installed in accordance with Clause 3.9.7.1.2 (see Notes 1 and 5).

This arrangement is regarded as unprotected consumer mains.

* Unprotected consumer mains are those that are not protected by a service protective device (SPD) as shown in Figure 2.1. Refer to

Figures 5.6(A), 5.6(B) and 5.6(C) for the earthing requirements for enclosures containing service protection devices.

FIGURE 2.1 TYPICAL EXAMPLES OF UNPROTECTED AND PROTECTED CONSUMER MAINS

NOTES:

1. Where consumer mains provide supply to safety services, compliance with Clause 7.2.2 is also required. Negotiation with the electricity distributor during installation planning stage is recommended.
2. An electricity distributor’s low voltage service protective device may provide overload and short-circuit protection for consumer mains and may satisfy Clauses 2.5.3.3 and 2.5.4.3 under certain conditions. Negotiation with the electricity distributor during installation planning stage is recommended.
3. An electricity distributor’s low voltage service protective device may provide short-circuit protection only for consumer mains under certain conditions. Negotiation with the electricity distributor during installation planning stage is recommended.
4. Where no low voltage service protection device is installed on the secondary side of an electricity distributor’s transformer, an appropriately sized high voltage fuse or circuit-breaker may provide short-circuit protection for the consumer mains under certain conditions. Negotiation with the electricity distributor during installation planning stage is recommended.
5. Consumer mains supplying one or more circuits that are individually protected against overload should be provided with overload protection where the sum of the current ratings of the individual circuit-breakers so supplied exceeds the current-carrying capacity of the consumer mains.
   * + 1. *Submains and final subcircuits—General arrangement*

An overcurrent protective device or devices ensuring protection against overload current and short-circuit current shall be placed at the origin of every circuit and at each point where a reduction occurs in the current- carrying capacity of the conductors.

* NOTE: The general arrangement of protective devices is shown in Figures 2.2(A) and 2.2(B).

*Exceptions:*

1. *Overcurrent protective devices shall not be provided on circuits where the unexpected interruption of the supply could cause a greater danger than overcurrent (see Clause 2.5.1.4).*
2. *Overcurrent protective devices may be located at an alternative position in accordance with Clauses 2.5.3.3 and 2.5.4.4.*
3. *Overcurrent protective devices may be omitted in accordance with Clauses 2.5.3.4 and 2.5.4.5.*
   * + 1. *Omission of protective device for safety reasons*

Devices for protection against overcurrent shall not be provided for circuits where unexpected opening of the circuit could cause a danger greater than overcurrent.

NOTES:

* + - * 1. Examples of such circuits are certain safety system supplies, lifting magnets, exciter circuits of machines and the secondary circuits of current transformers. In such cases, the provision of an overload alarm is strongly recommended.
        2. The omission of protective devices is shown in Figure 2.3.

## 2.5.2 Devices for protection against both overload and short-circuit currents

Protective devices providing protection against both overload and short- circuit current shall be capable of breaking any overcurrent up to and including the prospective short-circuit current at the point where the device is installed.

The device shall comply with the requirements of Clauses 2.5.3 and 2.5.4.

*Exception: A protective device having a breaking capacity below the value of the prospective short-circuit current may be used in conjunction with another device in accordance with Clause 2.5.7.2.*

Protective devices may be one of the following:

1. Circuit-breakers incorporating short-circuit and overload releases.
2. Fuse-combination units (CFS units).
3. Fuses having enclosed fuse-links (HRC fuses).
4. Circuit-breakers in conjunction with fuses. Semi-enclosed rewireable fuses shall not be used.

NOTES:

* 1. General-purpose fuses (Type gG) and overcurrent circuit-breakers normally combine overload and short-circuit protection in the one device.
  2. A fuse comprises all the parts that form the complete protective device.
  3. Circuit-breakers that meet the requirements for the type of protection required and replace a fuse-carrier by insertion in a fuse base are acceptable. However, because of interchangeability with semi-enclosed rewireable fuse-carriers, such circuit-breakers should be rated at not more than 80% of the current-carrying capacity of the protected conductor.
  4. Screw-type fuses of the enclosed type that meet the requirements of IEC 60269-3 System A Type D are acceptable.

\*

## Protection against overload current

* + - 1. *Coordination between conductors and protective devices*

The operating characteristics of a device protecting a conductor against overload shall satisfy the following two conditions:

*I*B  *I*N  *I*Z . . . 2.1

*I*2  1.45  *I*Z . . . 2.2

where

*I*B = the current for which the circuit is designed, e.g. maximum demand

*I*N = the nominal current of the protective device

*I*Z = the continuous current-carrying capacity of the conductor (see the AS/NZS 3008.1 series)

*I*2 = the current ensuring effective operation of the protective device and may be taken as equal to either—

* + - * 1. the operating current in conventional time for circuit- breakers (1.45 *I*N); or
        2. the fusing current in conventional time for fuses (1.6 *I*N for fuses in accordance with the IEC 60269 series).

NOTES:

1. To satisfy Equation 2.2, the nominal current *I*N of a fuse should not exceed 90% of *I*Z (1.45/1.6 = 0.9), therefore—

for circuit-breakers Equation 2.1 applies

for HRC fuses *I*B  *I*N  0.9*I*Z . . . 2.3

1. For adjustable devices, the nominal current *I*N is the current setting selected.
2. Protection in accordance with this Clause will not ensure complete protection in certain cases, e.g. against sustained overcurrent less than *I*Z, nor will it necessarily result in an economical solution. Therefore, it is assumed that the circuit is so designed that small overloads of long duration will not frequently occur. Such overloads can cause premature ageing of the insulation.
3. For further information, see Paragraph B3.2.1, Appendix B.

* **2.5.3.2** *Position of overload protective device—General arrangement*

In accordance with Clause 2.5.1.3, a device providing protection against overload shall be installed at the origin of every circuit and at each point where a reduction occurs in the current-carrying capacity of the conductors.

*Exception: In accordance with the conditions set out in Clauses 2.5.3.3 and 2.5.3.4, an overload protective device may be located in another position or may be omitted.*

**2.5.3.3** *Alternative position of overload protective device*

A device providing protection of a conductor against overload current may be placed at a point other than the origin of the circuit provided that—

1. the conductor has no branch circuits or socket-outlets connected between the origin of the conductor and the overload protective device; or
2. the conductor supplies one or more circuits that are individually protected against overload, such as within a switchboard or busway, and the sum of the current ratings of the circuit protective devices supplied by the conductor does not exceed the current-carrying capacity of the conductor.

NOTE: Examples of alternative positions of overload protective devices are shown in Figures 2.4 and 2.5.

* **2.5.3.4** *Omission of overload protective device*

The following applies:

* 1. Where unexpected opening of the circuit could cause a danger greater than overload, devices for protection against overload current shall be omitted, in accordance with Clause 2.5.1.4.
  2. Devices for protection against overload current may be omitted provided that the conductor is not situated in a location presenting a fire risk, or a risk of explosion, or where requirements for special installations and locations specify different conditions, and the conductor—
     1. is situated on the load side of a change in current-carrying capacity that is effectively protected against overload by a protective device placed on the supply side of the origin of the conductor; or
     2. supplies electrical equipment that is not capable of causing an overload current and the conductor has no branch circuits or socket-outlets connected between the origin of the conductor and the electrical equipment; or
     3. is provided for installations of telecommunications, control, signalling and the like.

NOTES:

1. A heating appliance is an example of equipment not capable of causing an overload current.
2. Examples of omission of overload protection are shown at Figures 2.6 and 2.7.

## Protection against short-circuit current

NOTE: The requirements of this Clause only take into account cases of short- circuit anticipated between conductors belonging to the same circuit.

* + - 1. *Determination of prospective short-circuit current*

The prospective short-circuit current at every relevant point of the electrical installation shall be determined either by calculation or by measurement.

* **2.5.4.2** *Characteristics of short-circuit protective devices*

Short-circuit protective devices shall meet the following conditions:

* 1. The breaking capacity shall be not less than the prospective short- circuit current at the point where the devices are installed.

*Exception: A device having a lower breaking capacity is permitted if another protective device having the necessary breaking capacity is installed on the supply side. In this case, the characteristics of the devices shall be coordinated so that the energy let through by these two devices does not exceed that which can be withstood without damage by the device on the load side and the conductors protected by those devices.*

NOTE: In certain cases, other characteristics may need to be taken into account, such as dynamic stresses and arcing energy, for the device on the load side. Details of the characteristics needing coordination should be obtained from the manufacturers of the devices concerned.

* 1. All currents caused by a short-circuit occurring at any point of a circuit shall be interrupted before the temperature of the conductors reaches the permissible limit.

For short-circuits of duration up to 5 s, the time in which a given short- circuit current will raise the conductors from the highest permissible temperature in normal duty to the maximum permissible short-circuit temperature may, as an approximation, be calculated from the following equation:

*K* 2*S*2

*t*  *I* 2 . . . 2.4

where

*t* = duration, in seconds

*K* = factor dependent on the material of the conductor, the insulation and the initial and the final temperatures

*S* = cross-sectional area of the conductor, in mm2

*l* = effective short-circuit current, in amps (r.m.s)

NOTES:

1. Values of *K* for conductors in various conditions of service are given in the AS/NZS 3008.1 series, e.g.—

For PVC insulated copper conductors of cross-sectional area not more than 300 mm2, *K* = 111 for 75°C initial conductor temperature.

1. For very short duration (<0.1 s) where asymmetry of the current is of importance and for current limiting devices, *K*2*S*2 should be greater than the value of the let-through energy (*I*2*t*) stated by the manufacturer of the protective device.
2. The nominal current of the short-circuit protective device may be greater than the current-carrying capacity of the cable.
3. Other methods of calculation are permissible.

**2.5.4.3** *Position of devices for short-circuit protection*

In accordance with Clause 2.5.1.3, a device providing protection against short-circuit shall be installed at the origin of every circuit and at each point where a reduction occurs in the current-carrying capacity of the conductors.

*Exception: In accordance with the conditions set out in Clauses 2.5.4.4 and 2.5.4.5, a short-circuit protective device may be located in another position or may be omitted.*

NOTE: Such devices may be circuit-breakers with a short-circuit release or HRC fuses.

* **2.5.4.4** *Alternative position of short-circuit protective device*

**2.5.4.4.1** *General*

A device providing protection against short-circuit current may be placed at another point in the circuit under the conditions of Clauses 2.5.4.4.2 or 2.5.4.4.3.

* **2.5.4.4.2** *Condition 1*

The part of the conductor between the point of reduction of cross-sectional area or other change and the position of the protective device shall be such that—

* 1. its length does not exceed three metres; and
  2. it is protected mechanically or otherwise so that the risk of short-circuit is reduced to a minimum; and
  3. it is installed in such a manner as to reduce to a minimum the risk of fire or other danger to persons, livestock and property.

NOTES:

1. Insulated conductors in a metallic wiring enclosure are considered to comply with this requirement.
2. An example of the alternative position of a short-circuit protective device is shown at Figure 2.8.

**2.5.4.4.3** *Condition 2*

A protective device may be placed on the supply side of the reduced cross- sectional area or other change, provided that it possesses an operating characteristic such that it protects the circuit situated on the load side against short-circuit, in accordance with Clause 2.5.4.5.

NOTE: This may be verified by comparing the short-circuit current level just before the branch device with the performance characteristics of the preceding device.

**2.5.4.5** *Omission of devices for short-circuit protection*

Devices for protection against short-circuit current may be omitted under the following conditions:

1. Where unexpected opening of the circuit could cause a danger greater than short-circuit, devices for protection against short-circuit shall be omitted, in accordance with Clause 2.5.1.4.
2. Consumer mains constructed in accordance with Clause 3.9.7.1 need not be provided with short-circuit protection.
3. Conductors connecting generators, transformers, rectifiers or batteries to their associated switchboards need not be provided with short- circuit protection provided that—
   1. the wiring is carried out in such a way as to reduce the risk of a short-circuit to a minimum; and
   2. the wiring is not placed close to flammable material; and
   3. the short-circuit protective devices for the remainder of the circuit are placed on the associated switchboard.

## NOTE: Examples of the omission of devices for short-circuit protection are shown in Figures 2.3 and 2.2.5.5 Protection against switchboard internal arcing fault currents

* + - 1. *General*

## Protection against arcing fault currents while the equipment is in service, or is undergoing maintenance, shall be provided for switchboards rated at 800 A or greater per phase.

The supply conductors up to the line side of the protective device(s) within the switchboard shall be provided with means to reduce the probability of initiation of arcing faults by insulation or by separation.

NOTES:

* + - * 1. Refer to AS/NZS 3439.1 or AS/NZS 61439.1 for switchboard requirements and AS/NZS 3439.2 or AS/NZS 61439.6 for busways.
        2. See also Clause 2.5.1.2 regarding requirements for consumer mains.
        3. Separation of live supply conductors from each other by insulation or barriers in accordance with this Clause (Clause 2.5.5.1) is not required,

e.g. an IP2X enclosure with bare busbars is acceptable.

In addition, the switchboard shall comply with one of the following:

1. Clause 2.5.5.2 to reduce the probability of initiation of a switchboard internal arcing fault.
2. Clause 2.5.5.3 to limit as far as practicable the harmful effects of an internal arcing fault.
3. One of the forms of internal separation required by Clause 2.5.5.2 together with Clause 2.5.5.3 to reduce the probability of initiation and limit, as far as practicable, the harmful effects of an internal arcing fault.

* **2.5.5.2** *Reduction of the probability of the initiation of a switchboard internal arcing fault*

Switchboards rated at 800 A or greater per phase shall be provided with internal separation in accordance with AS/NZS 3439.1 or AS/NZS 61439.2 for—

* 1. busbars from functional units;
  2. functional units from one another (refer to Figure 2.11);
  3. terminals provided for external conductors from the busbar; and
  4. a safety service circuit section of the switchboard, if any, from the general installation circuit’s section, in accordance with Clause 7.2.

NOTES:

1. Separation in accordance with AS/NZS 3439.1 or AS/NZS 61439.2 may be achieved by the insulation of busbars, the use of barriers or by insulated housings, i.e. by the use of a Form 3b, Form 3bi, Form 3bh, Form 3bih, Form 4a, Form 4ah, Form 4aih or Form 4b, Form 4bi, Form 4bh, Form 4bih constructed switchboard.
2. The required degree of protection, IP2X or IP1XB, is to prevent the entry of objects and contact with live parts by a person’s finger. To prevent the entry of tools or wires, the degree of protection may be increased, i.e. small tools IP3X or IP2XC (2.5 mm diameter) and wires IP4X or IP3XD (1 mm diameter).
3. Internal arc fault testing of switchboard designs to Annex ZD of AS/NZS 3439.1:2002 or AS/NZS 61439, or IEC/TR 61641 is not required and is considered to be an enhancement of internal separation. These designs are intended to prevent the arc or products of the arc affecting other parts of the switchboard. Arc fault containment is achieved by the arrangement of the busbars and functional units of the switchboard in vented

compartments and relies, for its effectiveness, on compartment access doors being closed during a fault. It is not designed to prevent the initiation of a fault during maintenance and is also not designed to provide switching operator or maintenance personnel protection if any covers are not properly fixed in place.

**2.5.5.3** *Limitation of the harmful effects of a switchboard internal arcing fault*

Protective devices shall be provided to limit, as far as practicable, the harmful effects of a switchboard internal arcing fault by automatic disconnection.

The arcing fault current between phases, or between phase and earth, is deemed to be in the range of 30% to 60% of the prospective short-circuit current.

Protection shall be initiated, i.e. pick up at a current less than 30% of the three-phase prospective fault level.

To minimize damage to the switchboard, the interrupting time shall not exceed the value obtained from the following equation.

The general damage limit is given by the following:

Clearing time *t*  *k*e  *l*r

*l*

1.5

f

|  |  |  |
| --- | --- | --- |
| where  *t* | = | clearing time, in seconds |
| *l*f | = | 30% of the prospective fault current |
| *l*r | = | current rating of the switchboard |
| *k*e | = | 250 constant, based on acceptable volume damage |

*Example*:

*The maximum arcing fault clearing time at a customer’s 800 A-rated main switchboard with a prospective fault current at the switchboard of 16.67 kA.*

*Therefore—*

*If = 30% of 16.67 kA = 5 kA*

*t*  250  800  0.57 *s*

50001.5

*i.e. the protective device settings are set to clear an arcing fault of 5 kA in less than 0.57 s.*

NOTE: Overcurrent protective devices should be set to as low an initiation current as possible while still maintaining the correct function of the installation,

e.g. set higher than motor-starting currents.

Earth fault protective devices shall have a maximum setting of 1200 A.

The settings of protective devices shall be verified by inspection [see Clause 8.2.2(c)(ii)].

NOTE: The electricity distributor should be consulted for discrimination requirements between installation protective devices and the electricity distributor’s service protective devices. The curves and settings of service protective devices will be required.

Where arc detectors are used, immunity to extraneous light sources that may cause operation of the protection is necessary. Arc detectors do not obviate requirements for discrimination.

## Coordination of overload and short-circuit protective devices

* + - 1. *Protection afforded by one device*

An overload protective device that complies with Clause 2.5.3 and has a breaking capacity not less than the value of the prospective short-circuit current at its point of installation may be deemed to protect the conductor on the load side of that point against short-circuit currents and overload currents.

NOTE: This consideration may not be valid for short-circuit currents lower than the prospective value, or for certain types of circuit-breakers, especially non-current-limiting types. Its validity should be checked, in accordance with the requirements of Clause 2.5.4.2.

* **2.5.6.2** *Protection afforded by separate devices*

The requirements of Clauses 2.5.3 and 2.5.4 apply respectively to the overload protective device and to the short-circuit protective device.

The characteristics of the devices shall be coordinated so that the energy let through by the short-circuit protective device does not exceed that which can be withstood without damage by the overload protective device in accordance with Clause 2.5.4.5(a).

The selection of protective devices shall be verified by inspection [see Clause 8.2.2(c)(ii)].

## Reliability of supply

* + - 1. *General*

The electrical installation shall be designed to provide a reliable supply by dividing the electrical installation into appropriate circuits and selecting protective devices with appropriate discrimination (selectivity) so that in the event of a fault occurring, the loss of supply resulting from operation of a protective device is minimized.

The selection and setting of protective devices shall be verified by inspection [see Clause 8.2.2(c)(ii)].

* + - 1. *Coordination of protective devices*
* **2.5.7.2.1** *General*

Coordination of protective devices requires consideration of both discrimination (selectivity) and backup (cascading) protection.

Discrimination (selectivity) between protective devices depends on the operating characteristics of two or more protective devices such that the protective device for the downstream circuit shall operate for a given fault current while the protective device(s) for the upstream circuit shall not operate.

Backup (cascading) depends on the characteristics of each of the two devices as well as the behaviour of the two devices when operating in series. This includes the energy let through when sharing the fault as well as the peak current withstand of the downstream device.

NOTE: Manufacturer’s instructions/data should be used where available.

Figure 2.12 provides a generic overview of discrimination (selectivity) between protective devicesNOTES:



1

1. Discrimination (selectivity) is achieved when PD 1 remains intact while PD 2 clears a fault on the load side. Thus supply is maintained to PD 3 and the remainder of the electrical installation.
2. For examples and detailed requirements of compliant time-current curves, see Figures 2.13 to 2.18.
3. Discrimination (selectivity) need not apply where protective devices are in series on the same circuits such as in UPS connected supplies.

* **2.5.7.2.2** *Safety service circuit discrimination (selectivity)*

A fault current up to the level of an arcing fault current—

* 1. on one safety service circuit shall not result in loss of supply to other safety service circuits; and
  2. on the general electrical installation shall not result in loss of supply to safety services.

Discrimination (selectivity) shall be provided between protective devices up to the level of an arcing fault current, which is deemed to be in the range of 30% to 60% of the prospective short-circuit current in accordance with Clause 7.2.3.5.

NOTE: An example of protective devices and the arcing fault current is shown in Figure 2.13.

* **2.5.7.2.3** *General supply circuit discrimination (selectivity)*

In accordance with Clause 2.5.7.1, to minimize loss of supply, discrimination (selectivity) shall be arranged between protective devices for outgoing circuits and the upstream protective device.

Discrimination is achieved using a discrimination study, the ratios shown below or manufacturer’s data and tables. Circuit-breakers with curves shown in AS/NZS IEC 60947.2:2015 Figure K.1, current limiting and reflex tripping circuit-breakers may require special consideration.

Discrimination need not apply above the arcing fault current *I*arc which is deemed to be in the range of 30% to 60% of the prospective short-circuit current.

Discrimination need not apply where protective devices are in series on the same circuit such as in UPS connected supplies.

Refer to Figure 2.13.

Downstream devices shall be selected to discriminate (provide selectivity) with upstream devices, using time-current curves, in accordance with the following:

1. *Circuit-breakers* Two circuit-breakers, connected such that *C*2 is the downstream device and *C*1 the upstream device, shall be selected:
   1. For ratings of *C*2 greater than or equal to 800 A, discrimination shall be provided by a coordination study using manufacturer’s data.

NOTE: Curve references are found in AS/NZS IEC 60947.2:2015, Figure K.1.

Allowance for tolerances on settings may be required. Refer to Figure 2.14.

* 1. For ratings of *C*2 greater than 250 A, and less than 800 A, discrimination shall be provided between overload curves.

Discrimination is deemed to be achieved if the overload setting of

*C*1  1.5  *C*2, e.g. *C*1 1000 A with *C*2 630 A.

Refer to Figure 2.15.

* 1. For ratings of *C*2 less than 250 A, discrimination is deemed to be achieved if *C*1  1.5  *C*2, e.g. *C*1 MCB marked C63 with MCB *C*2 marked C40 (i.e. both C curves).

NOTES:

* + 1. *I*SD is not available on MCBs and only available on some MCCBs with electronic trip units.
    2. Where a circuit-breaker is installed for load limiting purposes, such as on submains, reliability of supply is not required.

1. *Fuses* Two fuses connected such that *F*2 is the downstream device and *F*1 the upstream device shall be selected such that the characteristics of the devices provide discrimination (selectivity) on overload (see Figure 2.17).

Discrimination (selectivity) between HRC fuses is deemed to be achieved—

* 1. For overload when *F*1  1.6  *F*2, e.g. 16 A with 10 A; and
  2. For short-circuit when *F*1  2  *F*2, e.g. 20 A with 10 A.

NOTE: Overload curves are those for times >0.01 s. Short-circuit data is based on the total *I*2*t* of *F*2  pre-arcing *I*2*t* of *F*1.

1. *Fuse and circuit-breaker* A fuse and a circuit-breaker connected such that *C*2 is the downstream device and *F*1 the upstream device shall be selected such that the characteristics of the devices provide discrimination (selectivity) between the overload curve and the instantaneous setting or short delay setting (*I*SD) of *C*2 and the time- current curve of *F*1.

Back up fuses are not required to discriminate. For service fuses refer Note 5.

NOTES:

1. A coordination study requires the calculation of the prospective short-circuit currents, and comparison of the operating time of various protective devices, taking into consideration the actual current seen by each protective device. Manufacturer’s data should be used to assess coordination (discrimination and back up) in the short-circuit area (above the short delay or Instantaneous setting of the protective devices).
2. Detailed requirements for coordination (selectivity and back up) as well as symbols, figures and examples are given in relevant Standards as follows: MCCBs and ACBs—AS/NZS IEC 60947.2, MCBs—AS/NZS 60898.
3. If devices are to be installed above their rated short-circuit capacity, the backup protection (cascading) requirements for circuit-breaker or fuse selection needs to be determined from manufacturer’s data. Discrimination (selectivity), when backup protection of a circuit-breaker is applied, is limited (partial) and the value needs to be obtained from the manufacturer.
4. Refer to Clause 2.5.5 for other requirements for 800 A main switchboards.
5. The electricity distributor should be consulted for discrimination requirements between installation protective devices and the electricity distributor’s service protective devices. The curves and settings of service protective devices will be required. For example, a 100 A service fuse will discriminate with a 32 A MCB.
6. Discrimination requirements are not retrospective.
7. The following terms are used in Figures 2.13 to 2.18:

*I*PSC = prospective short-circuit current (see Clause 1.4.43) *I*arc = deemed maximum arcing fault current (= 60% *I*PSC) *I*i = instantaneous setting

*I*SD = short delay setting

0.01 s = the limit of fuse time-current.

# ADDITIONAL PROTECTION BY RESIDUAL CURRENT DEVICES

## General

The use of fixed setting RCDs with a rated operating residual current not exceeding 30 mA is recognized as providing additional protection in areas where excessive earth leakage current in the event of failure of other measures of protection or carelessness by users could present a significant risk of electric shock.

NOTE: The use of RCDs is intended only to augment other measures of basic protection.

RCDs do not provide protection against faults between live conductors, nor do they provide protection against voltages imported into the electrical installation earthing system through the supply system neutral conductor.

The use of such devices is not recognized as a sole means of protection and does not obviate the need to apply the protective measures specified in Clause 2.4.

Additional protection shall be provided, where required by Clause 2.6.3, to automatically disconnect the supply when an earth leakage current reaches a predetermined value.

NOTES:

1. The requirements in these rules are for RCDs with a maximum sensitivity of 30 mA (can be either 10 mA or 30 mA).
2. RCDs with a sensitivity of 30 mA are designed to operate before fibrillation of the heart occurs.
3. RCDs with a sensitivity of 10 mA are designed to operate before muscular contraction, or inability to let go occurs. Muscular contraction can result in inability to breathe. Infants may be more prone to this risk.

## Selection and arrangement of devices

* + - 1. *General*

Any device for the provision of additional protection shall be capable of interrupting the part of the circuit protected by the device when an earth leakage current is above a predetermined value.

The load current rating of an RCD shall be not less than the greater of the following:

1. The maximum demand of the portion of the electrical installation being protected by the device.

*or*

1. The highest current rating of any overload protective device on the portion of the electrical installation being protected.

No earthing or protective bonding conductor shall pass through the magnetic circuit of an RCD.

RCDs shall be so selected, and the electrical circuits so subdivided, that any earth leakage current that may be expected to occur during normal operation of the connected load or loads will be unlikely to cause unnecessary tripping of the device.

NOTES:

1. To avoid unwanted tripping because of leakage currents and transient disturbances, care should be taken to ensure that the sum of the leakage currents of electrical equipment on the load side of an RCD is significantly less than its rated residual current. RCDs may operate at any value of residual current in excess of 50% of the rated residual current.

The loading of the circuit should be such that the leakage current does not exceed one-third of the rated residual current.

1. To avoid excessive leakage current causing unwanted tripping where socket-outlets are protected by one RCD having a rated residual current not greater than 30 mA, consideration should be given to the number of socket- outlets protected and the nature of electrical equipment likely to be connected to the socket-outlets.
   * + 1. *Types of RCD*
          1. *General*

\* RCDs shall be fixed setting RCDs complying with AS/NZS 3190, AS/NZS 61008.1, AS/NZS 61009.1, or IEC 62423 and intended for use in electrical installations.

NOTES:

The following Notes apply to both Australia and New Zealand:

1. Common types of RCDs and their applications are described as follows:
   1. Type AC RCD (marked with the A black and white logo

      Description automatically generated symbol), for which tripping is ensured for residual sinusoidal alternating currents.

This is the general type used in Australia but is not used in New Zealand.

* 1. Type A RCD (marked with the A black and white race track

     Description automatically generated symbol), for which tripping is ensured—
     1. as for Type AC; and
     2. for residual pulsating direct currents.
  2. Type I RCD, for which tripping is ensured—
     1. as for Type A; and
     2. with rated residual alternating current not exceeding 10 mA with an interrupting time not exceeding 40 ms at rated residual current.

RCDs with rated residual currents not exceeding 10 mA but with an interrupting time exceeding 40 ms but not exceeding 300 ms at rated residual current are treated as Type A devices and marked ‘General Type, Not for Patient Areas’ in accordance with AS/NZS 3190, AS/NZS 61008.1 and AS/NZS 61009.1.

* 1. Type F RCD, (F signifying frequency; marked with the symbols shown on right), for which tripping is ensured—
     1. as for Type A;
     2. for composite residual currents, whether suddenly applied or slowly rising intended for circuit supplied between phase and neutral or phase and earthed middle conductor; and
     3. for residual pulsating direct currents superimposed on smooth direct current.

Type F RCDs are intended for the protection of circuits carrying high frequency leakage currents such as those associated with frequency converters and electronic ballasts.

* 1. Type B RCD (marked with the ensured—
     1. as for Type A;

symbol), for which tripping is

* + 1. for residual sinusoidal alternating currents up to 1000 Hz;
    2. for residual alternating currents or pulsating direct currents superimposed on a smooth direct current of 0.4 times the rated residual current (*I*dn); and
    3. for residual direct currents that may result from rectifying circuits.
  1. Type S RCD (S signifying selectivity and marked with the symbol), a specially designed RCD for which tripping is ensured after a predetermined operating time delay corresponding to a given value of residual current.

1. The waveform of a fault current to earth can affect the operation of an RCD and should be taken into account for the selection of the type of RCD. Users should consult the RCD manufacturer for correct selection. IEC 60755 Annex B contains a useful diagram of the likely form of the fault currents generated from circuits utilizing a variety of semiconductor devices and the selection of appropriate RCD types.
   * + - 1. *Australia only*

In Australia, the following provisions apply:

1. RCDs can have any number of poles but shall interrupt all active and neutral conductors in the following applications:
   1. RCDs used as leakage protection devices in medical treatment areas in accordance with AS/NZS 3003.
   2. RCDs incorporated into a socket-outlet (SRCDs) for alterations complying with Clause 2.6.3.2.5(a).
   3. RCDs located beside a socket-outlet and specifically intended for the protection of that socket-outlet for alterations complying with Clause 2.6.3.2.5(a).
2. RCDs shall be of the type for which tripping is ensured for residual sinusoidal alternating current.
   * + - 1. *New Zealand only*

In New Zealand, RCDs required by this Standard shall—

1. interrupt all live (active and neutral) conductors; and
2. be of a type for which tripping is ensured for residual alternating current and residual pulsating direct current.
   * + 1. *Protection against initiation of fire*

Although it is not a requirement of this Standard to provide additional protection against the initiation of fire caused by current leakage across insulation, a Type S RCD with a rated residual current in the range 100 mA to 300 mA may be used as a main switch in a domestic electrical installation, in addition to the requirements of Clause 2.6.3.

NOTE: Protection is not afforded to separated circuits typically used for extra- low voltage (ELV) lighting or against the initiation of fire from equipment operating at elevated temperatures.

* + - 1. *Arrangement*

Where additional protection of final subcircuits is required, in accordance with Clause 2.6.3, the final subcircuits shall be arranged as follows:

1. In all electrical installations where—
   1. the number of RCDs installed exceeds one; and
   2. more than one lighting circuit is installed, lighting circuits shall be distributed between RCDs.
2. In residential installations—
   1. not more than three final subcircuits shall be protected by any one RCD; and
   2. where there is more than one final subcircuit, a minimum of two RCDs shall be installed.

NOTE: These arrangements are intended to minimize the impact of the

operation of a single RCD.

## Additional protection by residual current devices

* **2.6.3.1** *General*

The requirements of this Clause for the installation of RCDs are in addition to the RCD requirements for electrical installations as specified in—

* 1. other Australian and New Zealand Standards, e.g. AS/NZS 3001, AS/NZS 3002, AS/NZS 3003, AS/NZS 3004 series and AS/NZS 3012;
  2. other Sections of this Standard, e.g.—
     1. Section 3 for protection against mechanical damage;
     2. Section 6 for baths, showers and other water containers; and
     3. Section 7 for special electrical installations; and
  3. the requirements and regulations of legislation, such as work health and safety legislation.

NOTE: In New Zealand, attention is drawn to the requirements of NZECP 55 for wiring and fittings located near conductive thermal insulation.

**NZ**

* **2.6.3.2** *Installation requirements—Australia only*

**A**

**2.6.3.2.1** *General*

RCD installation requirements, for Australia only, shall comply with Clauses 2.6.3.2.2 to 2.6.3.2.6.

*Exceptions: These requirements need not apply to the following:*

1. *Final subcircuits supplied at ELV in accordance with Clause 7.5.*
2. *Final subcircuits supplied from a separated supply in accordance with Clause 7.4.*

* **2.6.3.2.2** *Domestic and residential installations—Australia only*

**A**

Additional protection by RCDs with a maximum rated residual current of

30 mA shall be provided for all final subcircuits in domestic and residential electrical installations.

Where protection of final subcircuits is required, RCDs shall be installed at the switchboard at which the final subcircuit originates.

These installations include but are not limited to—

1. individual domestic electrical installations;
2. residential areas of electrical installations;
3. multiple residential electrical installations that are provided for common use; or
4. external lighting installations in common areas of multiple residential electrical installations.

*Exception: RCD protection need not apply to repairs undertaken in accordance with Clause 2.6.3.2.6.*

* **2.6.3.2.3** *Non-domestic and non-residential installations—Australia only*

**A**

*Types of installations*

These installations include, but are not limited to—

1. individual commercial or industrial electrical installations;
2. multiple commercial or industrial electrical installations that are provided for common use;
3. external lighting installations in common areas of multiple commercial or industrial electrical installations; or
4. commercial or industrial portions of mixed installations.

*Location of RCD protection*

Where protection of final subcircuits is required, RCDs shall be installed at the switchboard at which the final subcircuit originates.

*Exception: Where the wiring system is installed with additional mechanical protection as required by Clause 3.9.4, the RCD protection specifically intended for the protection of that socket-outlet can be installed at, or adjacent to, the socket-outlet (e.g. factory).*

*Requirements for additional protection*

Additional protection by RCDs with a maximum rated residual current of

30 mA shall be provided for final subcircuits with a rating not exceeding 32 A supplying—

1. socket-outlets;
2. lighting;
3. direct connected hand-held electrical equipment, e.g. directly connected tools; and
4. direct connected electrical equipment that represents an increased risk of electric shock.

Factors that may represent an increased risk of electric shock include but are not limited to—

* 1. external influences (refer Clause 1.5.14); and
  2. type of electrical installation and processes being conducted (e.g. workshops and particular industrial activities).

NOTE: For all other final subcircuits with a rating not exceeding 32 A for direct connected equipment, additional protection by RCDs with a maximum rated residual current of 30 mA should be considered.

*Exceptions: These requirements need not apply to the following:*

1. *Repairs in accordance with Clause 2.6.3.2.6.*
2. *Situations where the disconnection of a circuit by an RCD could cause a danger greater than earth leakage current (e.g. traffic signals).*
3. *Final subcircuits installed for the connection of specific items of equipment, provided that the connected equipment is designed, constructed and installed in such a manner that is not likely to present a significant risk of electric shock and—*
   1. *is required by the owner or operator to perform a function that is essential to the performance of the installation and that function would be adversely affected by a loss of supply caused by the RCD operation; or*
   2. *may cause spurious nuisance tripping through high leakage current being generated in the normal operation of the equipment (e.g. VSDs).*

*In addition where the specific item of equipment is connected by a plug and socket-outlet, that socket-outlet is—*

* *located in a position that is not likely to be accessed for general use; and*
* *clearly marked to indicate the restricted use of that socket-outlet and that RCD protection is not provided for that socket-outlet.*

1. *Where other methods of protection are applied, e.g. a separated supply in accordance with Clause 7.4.*

\* **2.6.3.2.4** *Home care installations—Australia only*

**A**

RCD requirements for medical electrical equipment in home care medical installations shall comply with AS/NZS 3003.

* NOTES:
  1. Some of these installations require a Type I RCD, with a maximum rated residual current of 10 mA.
  2. See Appendix M for further information on continuity of supply.
* **2.6.3.2.5** *Alterations to installations and replacement of switchboards— Australia only*

**A**

Additional protection by RCDs shall be provided in existing electrical installations where alterations or a switchboard replacement is completed.

The following provisions shall apply:

1. *Alterations* RCD protection shall be provided as required by Clause 2.6.3.2.2, 2.6.3.2.3 or 2.6.3.2.4, as applicable, where any alteration to an existing final subcircuit is undertaken.

Socket-outlets added to an existing circuit shall be protected by an RCD in accordance with the requirements for new subcircuits in the part of the installation in which they are located.

Where socket-outlets are added to an existing circuit and RCD protection is required, the RCD protection need only be fitted at the commencement of the additional wiring.

*Exception: Extensions to existing non-RCD-protected final subcircuits supplying lighting points only.*

1. *Switchboard replacement* Where all of the circuit protection on a switchboard is replaced, additional protection by RCDs as required by this Clause (2.6) shall be provided for the final subcircuits supplied from that switchboard.

* **2.6.3.2.6** *Repairs—Australia only*

The requirements of this Clause (2.6.3) need not apply where a socket- outlet, luminaire or single item of electrical equipment that is not RCD- protected is replaced with an equivalent item in the same location.

For the purpose of this Clause, the replacement of a single socket-outlet with a multiple socket-outlet assembly is deemed to be a repair.

* **2.6.3.3** *Installation requirements—New Zealand only*
* **2.6.3.3.1** *Residential installations—New Zealand only*

Additional protection by RCDs with a maximum rated residual current of 30 mA shall be provided for final subcircuits supplying—

1. one or more socket-outlets; or
2. one or more lighting points; or
3. directly connected hand-held electrical equipment, e.g. directly connected hair dryers or tools forming part of—
   1. individual domestic electrical installations;
   2. residential areas of other electrical installations (see Note below);
   3. multiple residential electrical installations that are provided for common use; or
   4. external lighting installations in common areas of multiple residential electrical installations.

Where protection of final subcircuits is required, RCDs shall be installed at the switchboard at which the final subcircuit originates.

*Exceptions:*

1. *This requirement need not apply to a final subcircuit for which a method of fault protection other than automatic disconnection of supply is applied, e.g. a separated supply in accordance with Clause 7.4 or supply at extra low voltage in accordance with Clause 7.5.*
2. *This requirement need not apply to a final subcircuit supplying a socket-outlet or a connecting device specifically for the connection of a fixed or stationary electric cooking appliance, such as a range, oven or hotplate unit provided that—*
   1. *the socket-outlet is located in a position that is not likely to be accessed for general purposes;*
   2. *the socket-outlet is clearly marked to indicate the restricted purpose of the socket-outlet.*

NOTES:

1. Residential electrical installations include those located in residential institutions, hotels, boarding houses, hospitals, accommodation houses, motels, hostels and the like.
2. This requirement applies to complete final subcircuits, not to additions or alterations of existing final subcircuits. Requirements for additions and alterations are in Clause 2.6.3.3.4.

* **2.6.3.3.2** *Non-residential installations—New Zealand only*

In New Zealand, the following requirements apply to non-residential locations:

1. *Education and childcare facilities*

Additional protection by an RCD with a maximum rated residual current of 30 mA shall be provided for final subcircuits supplying one or more socket-outlets having a rating not exceeding 30 A in—

* 1. kindergartens;
  2. day care centres for preschool children;
  3. schools for children up to and including school Year 13; and
  4. areas in tertiary education or vocational training facilities that are primarily used or intended for teaching or training.

1. *Junior education and childcare facilities*

Additional protection by an RCD with a maximum rated residual current of 10 mA shall be provided for socket-outlets in areas within a building primarily for the purpose of teaching or caring for children in—

* 1. kindergartens;
  2. day-care centres for preschool children; and
  3. schools for children up to and including school year eight.

NOTE: These RCDs need not be Type I as used for electrical medical devices.

1. *Other locations*

Socket-outlets with a rating not exceeding 30 A, and supplies to directly connected hand-held equipment, installed in the following locations, shall be protected by RCDs with a maximum rated residual current of 30 mA:

* 1. Outdoor locations.
  2. Locations that have easy or unsupervised public access.

NOTE: Typical examples include public areas of train stations, airports and shopping malls.

* 1. Amusement arcades.
  2. Sockets in damp situation zones as classified by Clauses 6.6 or 6.7.

1. *Particular types of equipment*

Socket-outlets for and supplies to the following types of equipment shall be protected by RCDs with a maximum rated residual current of 30 mA:

* 1. Children’s rides.
  2. Vending machines.

*Exceptions:*

1. *The requirements of Items (a), (b), (c) and (d) need not apply to the following:*
   * *Where other methods of fault protection other than automatic disconnection of supply are applied, e.g. a separated supply in accordance with Clause 7.4 or supply at extra low voltage in accordance with Clause 7.5.*
   * *Where the disconnection of a circuit by an RCD could cause a danger greater than earth leakage current.*
   * *Where socket-outlets that are part of a mining operation are supplied at reduced low voltage.*
2. *The requirement of Item (b) for additional protection by 10 mA RCDs need not apply to the following:*
   * *Socket-outlets mounted above 1.8 m from the floor or above*

*1.8 m from a platform that is accessible to children.*

* + *Socket-outlets specifically for the supply of electricity to information technology equipment or cleaning equipment that are clearly marked to indicate the restricted purpose of the socket- outlet and that 10 mA RCD protection is not provided.*
  + *Socket-outlets in corridors, halls, gymnasiums and similar areas where portable appliances are not likely to be used by children.*
  + *Areas occasionally used by children up to school year eight but primarily intended for the care or education of older age groups.*
  + *A socket-outlet or a connecting device specifically for the connection of a fixed or stationary appliance for cooking, such as a range, oven or hotplate unit provided that—*
    - *the socket-outlet is located in a position that is not likely to be accessed for general purposes;*
    - *the socket-outlet is clearly marked to indicate the restricted purpose of the socket-outlet; and*
    - *the socket is supplied by a dedicated circuit protected by a 30 mA RCD.*

NOTES:

1. Childcare facilities include any premises registered with local authorities as a day-care centre and or registered or licensed family day-care premises.
2. Where one clause requires 30 mA RCD protection of the final subcircuit, and this Clause requires 10 mA RCD protection of the socket-outlet; 30 mA RCD at the switchboard and a 10 mA RCD in the same room as, or incorporated into, the socket-outlet(s) would satisfy both these requirements.
3. Care should be taken to avoid nuisance tripping by limiting the number of socket-outlets protected by the same 10 mA RCD.
4. ‘Reduced low voltage’ means either (a) or (b):
   1. A single-phase system in which—
      1. the nominal line-to-line voltage does not exceed 110 V a.c.; and
      2. the nominal line-to-earth voltage does not exceed 55 V a.c.; and
      3. all exposed conductive parts are connected to the protective earthing conductor.
   2. A three-phase system in which—
      1. the nominal line-to-line voltage does not exceed 110 V a.c.; and
      2. the nominal line-to-earth voltage does not exceed 63.5 V a.c.; and
      3. all exposed conductive parts are connected to the protective earthing conductor.

\* **2.6.3.3.3** *Home care installations—New Zealand only*

The installation of medical electrical equipment in home care medical installations shall comply with AS/NZS 3003.

NOTES:

1. Some of these installations require a Type I RCD, with a maximum rated residual current of 10 mA and faster tripping time.
2. Further information on reliability of supply is provided in Appendix M.

**2.6.3.3.4** *Additions and alterations—New Zealand only*

The following requirements apply:

1. *General* Where all of the circuit protection on a switchboard is replaced, additional protection by RCDs as required by this Clause (Clause 2.6.3) shall be provided for the final subcircuits supplied from that switchboard.
2. *Socket-outlets* Socket-outlets added to an existing circuit shall be protected by an RCD in accordance with the requirements for new subcircuits in the part of the installation in which the sockets are located.

\* NOTE: Where socket-outlets are added to an existing final subcircuit and RCD protection of the subcircuit is required, installing the RCD at the origin

of the subcircuit is preferred; however, the RCD protection need only be fitted at the commencement of the additional wiring. The location of all such RCDs should be recorded at the switchboard from which the final subcircuit originates.

*Exceptions: These requirements need not apply to the following:*

1. *Where socket-outlets that are not RCD-protected are replaced, including the replacement of a single socket-outlet with a multiple socket-outlet assembly.*
2. *Where socket-outlets are added to an existing subcircuit under circumstances where an exception from either Clause 2.6.3.3.1 or Clause 2.6.3.3.2 applies.*

# PROTECTION AGAINST OVERVOLTAGE

## General

Where an electrical installation is protected against overvoltages that may cause danger to persons or property, the requirements of Clauses 2.7.2 and 2.7.3 shall apply.

NOTES:

1. The causes of overvoltage in an electrical installation include the following:
   1. An insulation fault between the electrical installation and a circuit of higher voltage.
   2. Switching operations.
   3. Lightning.
   4. Resonant phenomena.
2. Protection against overvoltages should be provided in areas where lightning is prevalent.

## Protection by insulation or separation

Measures to prevent danger because of faults between live parts of the electrical installation and circuits supplied at higher voltages shall consist of the following:

1. For conductors, the provision of adequate insulation screening or segregation of circuits in accordance with Clause 3.9.8.3.
2. For transformers, the provision of adequate insulation, screening or separation of windings.

Transformer windings that operate at different voltages shall be insulated from one another by insulation with a specified test voltage or alternatively separated from one another by means of a conductive screen connected to the protective earthing conductor so as to ensure automatic disconnection of the supply in the event of a fault.

## Protection by protective devices

Protective devices may be used to protect against the effects of overvoltage arising from such causes as lightning and switching operations.

Where installed, such devices shall—

1. limit the (transient) voltage to a value below the insulation level of the electrical installation or the part thereof that the device protects;
2. operate at voltages not less than or equal to the highest voltage likely to occur in normal operation; and
3. cause no hazard to persons or livestock during operation.

NOTES:

1. This Standard does not require installations to be protected against overvoltages from lightning. Reference should be made to AS/NZS 1768 for information that will assist in determining the risk of lightning for particular applications and suitable protection methods.
2. This Standard does not require surge protection devices (SPDs) to be installed. Appendix F is provided to give guidance on the appropriate selection and installation method for these devices.

# PROTECTION AGAINST UNDERVOLTAGE

## General

Suitable protective measures shall be taken where—

1. the loss and subsequent restoration of voltage; or
2. a drop in voltage,

could cause danger to persons or property.

*Exception: Where potential damage to electrical equipment is considered an acceptable risk, undervoltage protection may be omitted.*

NOTES:

1. Examples where the loss and subsequent restoration of voltage might cause danger include unexpected restarting of equipment, such as a guillotine, press or electrically operated gates. See also Clause 4.13 regarding protection of motors.
2. Failure to provide sufficient voltage will significantly reduce motor torque and will result either in an excessively long starting time or, for extreme cases, in failure to start.

The requirements of Clause 2.8.2 shall apply where an electrical installation is protected against undervoltage that may cause danger to persons or property.

NOTE: The causes of undervoltage in an electrical installation may include the following:

1. Overload, or conductors of inadequate cross-section, producing excessive voltage drop.
2. A fault in the high voltage supply system.
3. Failure of, or high impedance in, a supply conductor.

## Selection of protective device

The characteristics of the undervoltage protective device shall be compatible with the requirements of the appropriate Standards for starting and the use of electrical equipment.

Where the re-closure of a protective device is likely to create a dangerous situation, the re-closure shall not be automatic.

Instantaneous disconnection by the undervoltage device shall not be impaired by contacts that have intentional delays in their operation.

*Exception: The operation of undervoltage protective devices may be delayed if the operation of the protected electrical equipment allows a brief interruption or loss of voltage without danger.*

NOTES:

1. Protective devices having time-delay facilities should permit the starting of motors where the supply voltage exceeds 85% of rated voltage and continued operation where the voltage is within 10% of the rated voltage.
2. Examples of protective devices for undervoltage are—
   1. undervoltage relays or releases operating a switch or a circuit-breaker; and
   2. non-latched contactors.

# \* 2.9 PROTECTION AGAINST FIRE HAZARD DUE TO ARCING FAULTS

## 2.9.1 General

Protective devices, such as arc fault detection devices (AFDDs), may be used to protect against the effects of arc faults for final subcircuits, including fire hazards. Typical applications include the following:

1. In premises with sleeping accommodation.
2. In locations with risks of fire due to the nature of processed or stored materials (e.g. barns, wood-working shops, stores of combustible materials).
3. In locations with combustible construction materials (e.g. wooden buildings).
4. In fire propagating structures.

NOTE: See Appendix O for more details.

Where AFDDs are installed, the requirements of Clauses 2.9.2 to 2.9.4 apply.

NOTE: The use of AFDDs does not obviate the need to apply any other measures required by other clauses in this Standard.

## \* 2.9.2 Type

AFDDs shall comply with IEC 62606.

## 2.9.3 Rating

AFDDs shall have a load current rating no less than that of the associated circuit protective device.

## 2.9.4 Arrangement

AFDDs shall be located at the switchboard from which the final subcircuit being protected originates.

## 2.9.5 Alterations

The installation of AFDDs should be considered when carrying out alterations to final subcircuits in situations where existing wiring systems may significantly deteriorate.

NOTES:

* 1. Further guidance on AFDDs is provided in Appendix O.
  2. AFDDs may be used to supplement protection of aged wiring.
  3. Deterioration of circuits may include damage by vermin.

## 2.9.6 Final subcircuits in Australia

In Australia, this Standard does not require installation of AFDDs.

## 2.9.7 Final subcircuits in New Zealand

In New Zealand, all final subcircuits having a rating not exceeding 20 A supplying the following shall be protected by an AFDD:

1. Points in locations with the risk of fire due to the nature of processed or stored materials, e.g. barns, woodworking shops and stores of combustible materials.
2. Points in locations containing irreplaceable items.
3. Points in historic buildings constructed largely of flammable materials.
4. Final subcircuits supplying socket-outlets in school dormitories.

NOTES:

1. When considering possible deterioration of circuits, circuits passing through an area should be considered as well as those supplying equipment within the area.
2. Further guidance on AFDDs is provided in Appendix O.
3. AFDDs may be used to supplement protection of aged wiring.
4. Deterioration of circuits may include damage by vermin.

# 2.10 SWITCHBOARDS

## 2.10.1 General

**A switchboard or switchboards shall be provided in an electrical installation for the mounting or the enclosure of switchgear and protective devices.**

*Exceptions:*

1. *This requirement need not apply to switchgear and protective devices installed in a ground-mounted, cable-distribution cabinet in accordance with AS/NZS 3439.5 or AS/NZS 61439.5, that protect small submains teed off larger submains forming an underground reticulated wiring system and to which unskilled persons do not require access.*
2. *Where it is necessary to connect small submains to larger submains,*

*e.g. teeing-off large rising submains at each floor, or from large submains to a number of circuits at a switchboard, a short branch (length shall not exceed three metres) from a submain to a switchboard may be made with conductors of smaller current-carrying capacity, provided that such conductors comply with Clause 2.4.*

*Alternatively, the small submains may be protected by fuses or circuit- breakers complying with Clause 2.4 of this Standard in relation to the smaller conductors and suitably mounted or fixed at the point of teeing-off. If there are more than two tee-offs per phase at any one point, the fuses or circuit-breakers shall be deemed to constitute a switchboard.*

A main switchboard shall be provided for each electrical installation for the primary control and protective devices of the electrical installation including the main switch or switches.

*Exception: A main switch need not be located on a switchboard, or be readily accessible, where unauthorized operation may impair safety and the electrical installation is—*

* 1. *located on public land; and*
  2. *associated with telephone cabinets, traffic control signals and street furniture, such as bus shelters and the like; and*
  3. *otherwise controlled and protected in accordance with the requirements of this Standard.*

## Location of switchboards

* + - 1. *General*

**Switchboards shall be—**

1. **installed in suitable well-ventilated places;**
2. **protected against the effects of moisture to which they may be exposed; and**
3. **arranged so as to provide sufficient space for the initial installation and later replacement of individual items of the control and protective devices and accessibility for operation, testing, inspection, maintenance and repair.**

* **2.10.2.2** *Accessibility and emergency exit facilities*

Switchboards shall be—

* 1. located so that the switchboard and access to it is not obstructed by the structure or contents of the building or by fittings and fixtures within the building;
  2. provided with adequate space around the switchboard on all sides where persons are to pass to enable all electrical equipment to be safely and effectively operated and adjusted; and
  3. provided with sufficient exit facilities to enable a person to leave the vicinity of a switchboard under emergency conditions.

Sufficient access and exit facilities shall be achieved by the provision of the following:

* + 1. 1.0 m minimum distance from all faces of a closed switchboard that need to be accessible. In a domestic electrical installation this distance may be reduced to 0.6 m from the face of the switchboard.
    2. Unimpeded space of at least 0.6 m around switchboards with switchgear doors in any position and with switchgear in a fully racked- out position (see Figures 2.19 to 2.23).
    3. A minimum of two emergency exit paths, spaced well apart, where a switchboard—
       1. is rated as a circuit with a nominal capacity of not less than 800 A per phase; or
       2. is more than 3 m in length.

*Exception: Where a clear space of at least 3 m is provided in front of the switchboard and its equipment, including switchboard doors, in all normal positions of operating, opening and withdrawal, only one emergency exit path need to be provided. See Figure 2.24.*

* + 1. Openings or doorways that are at least 0.9 m wide by 2.2 m high to allow persons necessary access to the switchboard room or enclosure.

NOTE: Larger openings may be required to enable entry of prefabricated switchboards.

* Where switchboards are located opposite each other, the clearance shall be measured with all doors in the open position. See Figure 2.23.

Doors of switchrooms or other rooms dedicated to switchboards shall open in the direction of egress without the use, on the switchboard side of the door, of a key or tool.

Where more than one switchroom door is provided for access to the same switchboard, the doors should be spaced well apart.

Doors of enclosures dedicated to switchboards that open into a passage or narrow access way shall be capable of being secured in the open position to prevent workers being inadvertently pushed towards the switchboard.

*Exception: The requirements for doors of switchrooms and for emergency exit facilities need not apply to single domestic electrical installations.*

NOTE: Consideration should be given to providing means of escape from the immediate vicinity of the switchboard in more than one direction, in case of an arcing fault occurring while work is in progress at the switchboard.

* + - 1. *Location of main switchboard*
* A main switchboard shall be located in accordance with the following:
  1. *General* The main switchboard shall be readily accessible. The main switchboard, or a panel for the remote control of main switches in accordance with Clause 2.3.3.6, shall be located within easy access of an entrance to the building.
  2. *Multiple electrical installations* In multiple electrical installations, the main switchboard shall not be located within any tenancy or single electrical installation of a multiple premise, either domestic or non- domestic.
     + 1. *Identification of main switchboard*

The main switchboard shall be legibly and permanently marked ‘MAIN SWITCHBOARD’.

Where a main switchboard is located within a room or enclosure, any door required for immediate personal access shall be prominently and permanently marked to identify the room or enclosure in which the main switchboard is located.

The location of the main switchboard shall be legibly and permanently indicated by a conspicuous notice at each entry to the building that may be used by emergency services personnel.

Notices indicating the location of the main switchboard shall be of permanent construction and shall incorporate the term ‘MAIN SWITCHBOARD’ in contrasting colours.

*Exceptions:*

1. *Identification of the main switchboard and its room or enclosure need not apply in a single domestic electrical installation.*
2. *The location of the main switchboard need not be marked at an entry to a building where the location is clearly indicated at a fire indicator panel.*
3. *The location of the main switchboard need not be marked where the location can be readily determined, e.g. where it is clearly visible from the main entrance to the electrical installation.*

NOTE: In New Zealand, any notice indicating the location of the main switchboard needs to comply with the New Zealand Building Code.

* **2.10.2.5** *Restricted locations*

Restricted locations for switchboards are as follows:

* 1. *Height above ground, floor or a platform* A switchboard shall not be located within 1.2 m of the ground, floor or platform.

*Exception: A switchboard may be located within 1.2 m of the ground, floor or a platform if access to live parts is arranged, in accordance with the requirements of Clause 2.10.3.1.*

* 1. *Water containers and fixed or stationary cooking appliances* A switchboard shall not be installed above open water containers or fixed or stationary cooking appliances.

NOTE: Refer to Item (d) below for baths and showers.

*Exception: A switchboard may be located in an area that may be affected by water splashing or by steam, provided that the switchboard is provided with a suitable enclosure or is installed in a cupboard with close-fitting doors.*

* 1. *In cupboards* A switchboard installed in a cupboard or similar enclosure shall only be installed in an area set aside for the purpose.

The provisions of Clause 2.10.2.2 require that the switchboard be designed and located to provide readily available access for the purposes of operation and maintenance of equipment mounted on the switchboard. The following restrictions apply to all switchboards.

The switchboard shall be—

* + 1. installed in a section of the cupboard separated from other sections;
    2. installed at the front of the switchboard section of the cupboard;
    3. facing the cupboard access door with insufficient unused space between the switchboard and the cupboard door, when closed, to store extraneous objects in front of the switchboard; and
    4. arranged so that below the area of the switchboard panel or enclosure, there are no projections that obstruct access for the operation and maintenance of the switchboard.
  1. *Near baths and showers* A switchboard shall not be installed within any zone classified in accordance with Clause 6.2.2 for a bath or shower.

NOTE: Areas in the proximity of a shower are deemed unsuitable for switchboards because of the prevalence of high humidity and condensation.

* 1. *Near swimming pools, spas or saunas* A switchboard shall not be installed within or above any zone classified in accordance with Clause 6.3.2 for a swimming pool or spa pool.

A switchboard shall not be installed within a sauna.

* 1. *Refrigeration rooms* A switchboard shall not be installed within a refrigeration room.
  2. *Sanitization or general hosing-down operations* Switchboards installed in classified zones in locations subject to sanitization or

hosing-down operations shall be provided with a minimum degree of protection of IPX6.

* 1. *Fire exits and egress paths* Switchboards shall be located or arranged to minimize the impact of any smoke generated from a fault in the switchboard affecting egress from the building.

A switchboard shall not be installed within a fire-isolated stairway, passage way or ramp.

A switchboard may be installed within a cupboard, or similar compartment, in other forms of required exit, or in any corridor, hallway, lobby or the like leading to such an exit, provided that the cupboard or compartment doors are sealed against the spread of smoke from the switchboard.

NOTES:

1. The compartment may be the switchboard enclosure, provided that the enclosure provides a seal to the ingress of dust to at least IP5X and is provided with a facility to be kept locked in normal service.
2. These restrictions are based on the provisions of national building codes to which reference should be made for definition of the terms and for exceptions that may apply.
   1. *Near fire-hose reels* A switchboard shall not be installed within a cupboard containing a fire-hose reel.

NOTE: Information on the installation of fire hydrants and fire-hose reels in buildings is given in national building codes and the AS 2419 series, or NZS 4510 and AS 2441.

* 1. *Near automatic fire-sprinklers* The following types of switchboards shall not be installed in the vicinity of an automatic fire-sprinkler system:
     1. Main switchboards.
     2. Switchboards from which safety services originate in accordance with Clause 7.2.

*Exception: A switchboard may be installed in the vicinity of an automatic fire sprinkler system if at least one of the following conditions is satisfied:*

1. *The switchboard is provided with degree of protection IPX4, in accordance with AS 60529.*
2. *The switchboard is provided with a shield to prevent water spraying on it.*
3. *Sprinkler heads that could project water on the switchboard are provided with suitable deflectors.*
4. *Sprinkler heads are of the dry type.*
   1. *Hazardous areas* Switchboards shall not be installed in hazardous areas as defined in AS/NZS 60079.10.1 or AS/NZS 60079.10.2.

*Exception: Switchboards constructed in accordance with AS/NZS 60079.14 may be installed within a hazardous area for which they are specifically designed.*

NOTES:

1. The following situations may give rise to a hazardous area:
   1. Heavier-than-air bottled flammable gas cylinders with an aggregate gas capacity exceeding 30 m3 [e.g. liquid petroleum gas (LPG)].
   2. Gas-tank filling or discharge connections.
   3. Pressure relief device discharge points fitted to gas installations.
2. Refer to AS/NZS 60079.10.1 for information regarding hazardous areas.

* 3 An example of the hazardous area/exclusion zone surrounding heavier- than-air gas cylinder is shown in Figure 4.18.

4 In New Zealand only, an example of the hazardous area/exclusion zone surrounding a reticulated (natural) gas system regulator is shown in Figure 4.20.

## 2.10.3 Construction

**2.10.3.1** *Access to live parts*

Live parts shall be arranged so that basic protection is provided by enclosures, in accordance with the provisions of Clause 1.5.4.

*Exception: Live parts may be exposed in a non-domestic electrical installation provided that—*

1. *the live parts are arranged so that basic protection is provided by barriers in accordance with the provisions of Clause 1.5.4.4; or*
2. *the switchboard is installed in an area that is accessible only to authorized persons and the means of access to such areas is provided with facilities for locking.*

In situations where the removal of covers and the like exposes live parts, such covers shall be identified in accordance with AS/NZS 3439.1 or AS/NZS 61439.1.

*Exception: This requirement does not apply to domestic switchboards.*

* **2.10.3.2** *Suitability*

Switchboards shall be suitable to withstand the mechanical, electrical and thermal stresses that are likely to occur in service, and the environment in which it is to be installed.

Switchboards complying with the relevant requirements of the AS/NZS 3439 or AS/NZS 61439 series are considered to meet the requirements of this Clause (2.10.3).

NOTES:

1. Appendix K provides guidance on the relevant design verification and validity tests applicable to switchboards complying with AS/NZS 61439 series. Appendix K is not a substitution for the requirements of AS/NZS 3439 or the AS/NZS 61439 series.
2. See also Clause 7.2 regarding segregation requirements for safety services.
3. See also Clause 2.5.5 regarding requirements for protection against the effects of arcing fault currents.

* **2.10.3.3** *Minimum clearances and creepage distances*

All bare conductors and bare live parts of a switchboard shall be rigidly fixed so that a minimum clearance or creepage distance in air, in accordance with the AS/NZS 3439 or AS/NZS 61439 series, is maintained between such conductors or parts of opposite polarity or phase and between such conductors or parts and earth.

Smaller values of clearances and creepage distances may be used—

1. for individual items of manufactured electrical equipment complying with the relevant standard; or
2. between a neutral bar and earth, provided that the neutral bar is insulated from earth.
   * + 1. *Orientation and location of fuses and circuit-breakers*

* **2.10.3.4.1** *Orientation of circuit-breakers*

Where two or more circuit-breakers are mounted in the same row, the operating mechanism of each shall cause the circuit to open when the operating means are orientated in one general direction.

Other arrangements are permitted where the open circuit condition of each device is obvious or where each device is clearly marked to indicate the off position.

* **2.10.3.4.2** *Location of fuses and circuit-breakers*

Fuses and circuit-breakers shall be located in the following ways:

* 1. *Grouping* Fuses and circuit-breakers shall be grouped in such a manner as to indicate their relationship to each other,

e.g. equipment—sump pump motor.

* 1. *On the back of switchboards or behind switchboard escutcheons* Fuses or circuit-breakers shall not be fixed on the back of, or behind, a switchboard panel, frame or escutcheon.

*Exceptions:*

1. *Fuses used for the following purposes may be fixed on the back of or behind, a switchboard panel, frame or escutcheon:*
   * *Used solely as a fault-current limiter.*
   * *Used to protect instruments or control equipment on the switchboard.*
2. *Circuit-breakers may be fixed on the back of, or behind, a switchboard panel frame or escutcheon—*
   * *provided that they may be operated from the front of the switchboard panel frame or escutcheon;*
   * *if used solely as a fault-current limiter; or*
   * *if used to protect instruments or control equipment on the switchboard.*
     + 1. *Screw-in fuses*

Fuses using screw-in carriers shall be connected so that the centre contact is on the supply side of the fuse base.

These fuses include IEC 60269-3 System A Type D.

## Bars

\* **2.10.4.1** *General*

Bars shall be provided with facilities for securely terminating conductors in accordance with Clause 3.7.

NOTE: Bars that comply with the relevant requirements of AS/NZS 5112 are deemed to comply with this Clause (2.10.4).

**2.10.4.2** *Tunnel-type terminals*

All screws that are in direct contact with conductors in tunnel-type terminals shall be of the type designed not to cut the conductor.

Where tunnel-type terminals having clamping screws that are in direct contact with the conductors are provided for connection of—

1. the main incoming neutral conductor;
2. the main earthing conductor;
3. the connection between the main earthing terminal/connection or bar and the neutral bar (MEN connection); or
4. a neutral conductor used as a combined protective earthing and neutral (PEN) conductor for protective earthing of any portion of an electrical installation,

the terminal shall be of a type having—

* 1. two screws; or
  2. one screw with an outside diameter not less than 80% of the tunnel diameter.

NOTE: This requirement does not apply to connections arranged so that the conductor is clamped by suitable ferrules or plates in direct contact with the conductor.

Tunnel-type terminals that comply with AS/NZS 5112 are deemed to comply with the above requirements.

* **2.10.4.3** *Neutral bar*

Every switchboard, to which a neutral conductor is connected, shall be provided with a neutral bar that is—

* 1. of adequate current-carrying capacity;

NOTE: The current-carrying capacity of the incoming neutral conductor may be used as a guide.

* 1. located in an accessible position to allow all conductors to be safely connected without moving other cables or isolating the supply to the switchboard;
  2. designed such that the incoming neutral conductor cannot be inadvertently disconnected from the bar or link; and
  3. provided with a separate terminal for—
     1. the incoming neutral conductor terminating at the switchboard; and
     2. the neutral conductor(s) associated with each outgoing circuit originating at the switchboard.

Where tunnel-type terminals are provided, the provisions of Clause 2.10.4.2 shall apply.

A neutral conductor or busbar connection may be used between the neutral bar and a number of multi-pole devices mounted on the switchboard. Where such an arrangement is used, the connection device shall comply with Clause 2.10.4.1 and, where appropriate, Clause 2.10.4.2.

Where a cable is used as the neutral conductor, and is looped between devices on the line side, the connection to each device shall be such that continuity remains when the device is removed. Twisting of conductors is not adequate.

*Exception: Where the connection is made at a terminal of switchgear in accordance with the manufacturer’s specifications, the provisions of Clauses 2.10.4.1 and 2.10.4.2 need not apply.*

## Equipment identification

* + - 1. *General*

## All equipment installed on a switchboard shall be legibly and indelibly identified in the English language in accordance with the requirements of Clauses 2.10.5.2 to 2.10.5.6.

NOTE: See Clauses 2.3.3 and 2.3.4 for the marking requirements for main switches and additional isolating switches.

* + - 1. *Relationship of electrical equipment*

The relationship of switches, circuit-breakers, fuses, RCDs and similar electrical equipment to the various sections of the electrical installation shall be marked on or adjacent to the switchboard.

The means of identification shall enable persons to readily identify equipment supplied and the corresponding circuit protective device.

* + - 1. *Bars*

Bars shall be identified to indicate whether they are active, neutral or earth.

*Exception: Bars need not be identified at switchboards where the colour of the basic insulation of the conductors connected is visible and clearly indicates the nature of the bar.*

\* **2.10.5.4** *Terminals of switchboard equipment*

Terminals of bars, circuit-breakers, fuses and other electrical equipment mounted on a switchboard shall be marked or arranged to identify the corresponding active and neutral connection for each circuit.

The terminals for the connection of the MEN connection and for the main neutral conductor shall be legibly and indelibly marked at the main neutral bar.

*Exceptions: This marking need not apply to the following:*

1. *Where the MEN connection is made at a terminal at one extremity of the bar.*
2. *Where the main neutral conductor is connected to the next adjacent terminal of the bar.*

Where the MEN connection is made at another location, such as a substation, in accordance with Clause 5.3.5.1, the location of the connection shall be legibly and indelibly marked at the main switchboard.

Compliance with AS/NZS 5112 satisfies the above requirements.

* + - 1. *Common neutral*

Where a common neutral is used for two or more different circuits it shall be legibly and permanently marked to identify the associated active conductors.

NOTE: The requirements of Clause 2.2.1.2 also apply to the use of a common neutral conductor.

* + - 1. *Fuse*

Where the marking of the fuse base does not correctly indicate the rating of the associated fuse-element, the rating of the fuse-element shall be marked either on an exposed non-detachable portion of the fuse or on its enclosing case, or on the switchboard adjacent to the fuse.

A number of fuses may be marked as a group, instead of independent marking adjacent to each fuse, where—

1. each fuse-element is of identical rating; and
2. the fuses are mounted adjacent to each other.

## Wiring

Switchboard wiring shall be designed and installed to withstand any thermal and magnetic effects on the conductors.

Where provision is made to hinge or remove switchboard panels, all conductors connected to electrical equipment on the switchboard panel shall be—

1. provided with sufficient free length to allow the panel to be moved into a position to enable work to be carried out;
2. suitably fixed or otherwise retained in position to avoid undue movement or stress at terminals of electrical equipment when the panel is moved or is fixed in position; and
3. arranged to prevent undue pressure on electrical equipment mounted behind the panel.

## Fire-protective measures

Wiring associated with switchboards shall be installed in such a manner that, in the event of fire originating at the switchboard, the spread of fire will be kept to a minimum.

Where a switchboard is enclosed in a case or surround, any wiring systems entering the switchboard enclosure shall pass through openings that provide a close fit.

NOTES:

1. See also Clause 2.10.2.5(h) regarding restricted location of switchboards in or near egress paths or fire exits and Clause 3.9.9 regarding requirements to prevent the spread of fire.
2. There is a very high risk that wiring enclosures, especially those that enter at the top or sides of a switchboard, will contribute to the spread of fire and for this reason care needs to be taken to ensure that these wiring systems are provided with close-fitting entries. In some cases internal sealing should be provided.
3. An opening with less than 5 mm diameter of free space is considered to be a close fit. Therefore, any opening of 5 mm diameter or greater requires sealing with a fire-retardant sealant.
4. Wiring enclosures, such as conduits, having an internal free space of greater than 5 mm diameter also require sealing to stop any draft effect that could allow the spread of fire.