

**Technical Note TN145**

# **Use of Residual Current Devices in Departmental Infrastructure**

**July 2015**

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## 1 Introduction

This Technical Note addresses the various types of fixed residual current devices (RCD) and their selection, installation, testing and application within the electrical infrastructure of the Queensland Department of Transport and Main Roads.

It is intended to provide designers with an understanding of how the RCD works, its advantages, disadvantages, limitations and what it can achieve along with the requirements of AS/NZS 3000:2007.

The intent of this document is to provide that technical background knowledge, as well as providing guidance based on a risk analysis, as to where the exception clause of AS/NZS 3000:2007 Part 2 may be applied to departmental electrical installations.

## 2 What is a residual current device?

The RCD is a 'mechanical switching device designed to make, carry and break currents under normal service conditions and to cause the opening of contacts when  $I_{\Delta}$  (the residual current) attains a given value under specified conditions' (AS/NZS 3190:2009).

In other words, the RCD is a circuit breaker that senses when the active and neutral currents in a circuit are not equal and, when that inequality reaches a predetermined value for a predetermined time, opens the breaker contacts.

These devices have also been called 'safety switches' and 'earth leakage circuit breakers'.

## 3 Reference documents

Documents that should be referenced to gain a better appreciation of RCDs and their application are:

**Table 3 – Referenced documents**

Reference	Title
AS/NZS 3000:2007	Wiring Rules
AS/NZS 3111:2009	Approval and test specification – Miniature overcurrent circuit-breakers
AS/NZS 3190:2009	Approval and test specification – Residual current devices (current-operated earth-leakage devices)
AS/NZS 61008.1:2004	Residual current operated circuit-breakers without integral overcurrent protection for household and similar uses (RCCBs) Part 1: General Rules
AS/NZS 61009.1:2004	Residual current operated circuit-breakers with integral overcurrent protection for household and similar uses (RCBOs) Part 1: General Rules
AS/NZS 60479.1:2010	Effects of current on human beings and livestock Part 1: General Aspects
AS/NZS 60898.1:2004	Electrical accessories – Circuit breakers for overcurrent protection for household and similar installations Part 1 Circuit-breakers for a.c. operation
AS/NZS 60898.2:2004	Circuit breakers for overcurrent protection for household and similar installations Part 2: Circuit-breakers for a.c. and d.c. operation
SAA HB113:1998	Residual Current Devices – What they do and how they do it
AS/NZS ISO 31000:2009	Risk management – Principles and guidelines

Reference	Title
Electrical Safety Code of Practice 2010 – Risk Management	

#### 4 Definitions relating to residual current devices

The following terms and abbreviations relate to RCDs (from AS/NZS 61008.1):

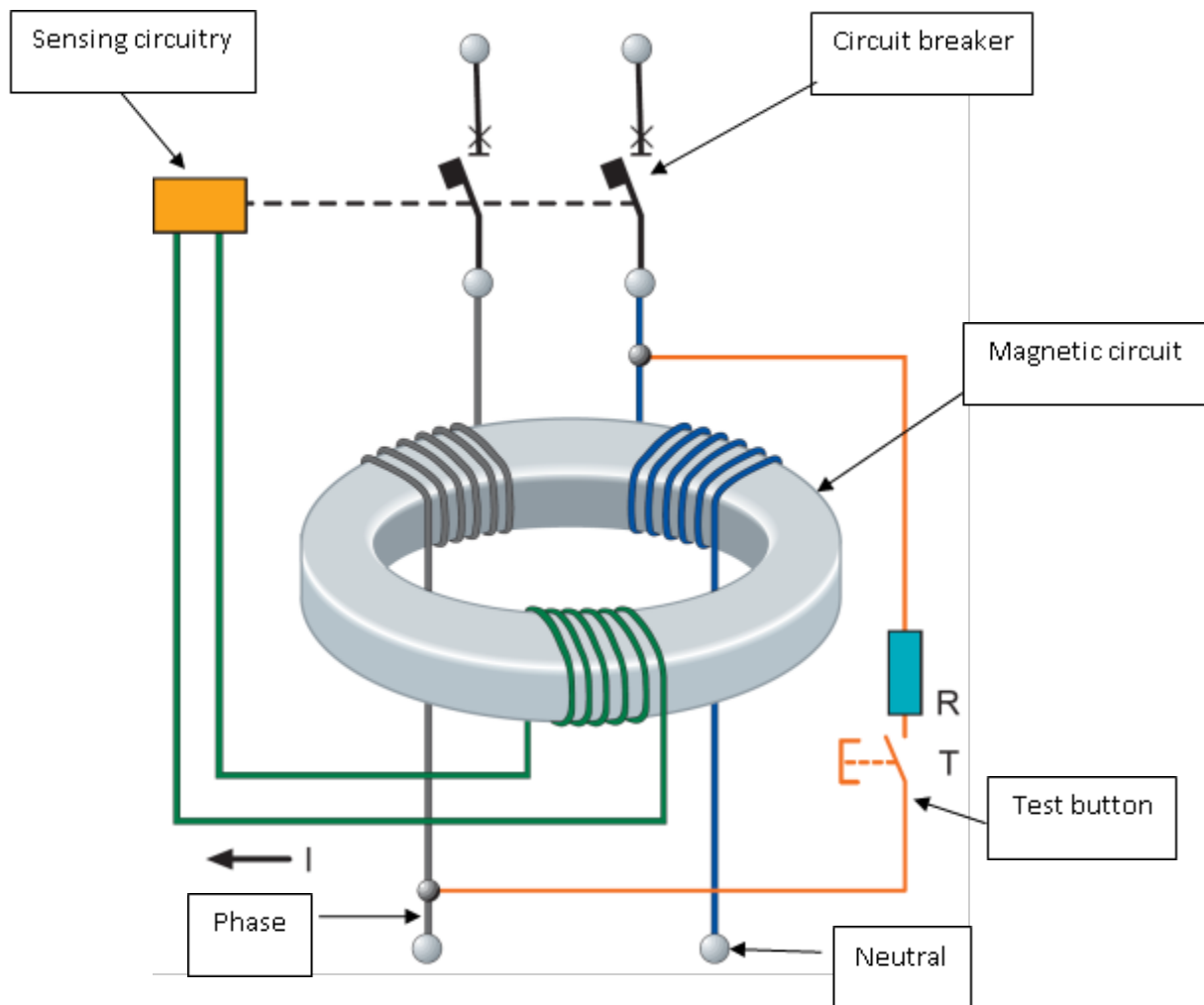
**Table 4 – Definitions relating to residual current devices**

Term	Definition
Break time of the RCD	The time which elapses between the instant when the residual operating current is suddenly attained and the instant of arc extinction in all poles (that is, the time for the fault to clear)
Earth fault current	Current flowing to earth due to an insulation fault
Earth leakage current	Current flowing from the live parts of the installation to earth in the absence of an insulation fault
Residual current	Vector sum of the instantaneous values of the current flowing in the main circuit of the RCD (expressed as rms value)
Residual current operated circuit-breaker	A mechanical device designed to make, carry and break currents under normal service conditions and to cause the opening of the contacts when the residual current attains a given value under specified conditions
Residual current operated circuit-breaker without integral overcurrent protection (RCCB)	A residual current operated circuit-breaker not designed to perform the functions of protection against overloads and/or short circuit
Residual current operated circuit-breaker with integral overcurrent protection (RCBO)	A residual current operated circuit-breaker designed to perform the functions of protection against overloads and/or short circuit
Residual making and breaking capacity	A value of the a.c component of a residual prospective current, which the RCD can make, carry for its opening time and break under specified conditions of use and behaviour
Residual operating current	Value of residual current which causes the RCD to operate under specified conditions

#### 5 How does the residual current device work?

In simple terms, the RCD is a circuit breaker that continuously compares the active current to the neutral current. The residual current will be the difference between the two. This residual current will be flowing to earth, because it has left the phase part of the circuit and has not returned in the neutral (in the multiple earthed neutral (MEN) system, there are multiple earth return paths available for this current). There will always be some residual current, due to the insulation resistance and capacitance to earth, but, in a healthy circuit, this current will generally be low, seldom exceeding 2 mA.

**Operating principle of the residual current release (from the ABB – Technical Application Papers 3)**



The main contacts are closed against the pressure of a spring, which provides the energy to open them when the device trips. Phase and neutral currents pass through identical coils wound in opposing directions on a magnetic circuit, so that each coil will provide equal but opposing numbers of ampere turns when there is no residual current. The opposing ampere turns will cancel, and no magnetic flux will be set up in the magnetic circuit.

Residual earth current passes to the circuit through the phase coil but returns through the earth path, thus avoiding the neutral coil, which will therefore carry less current. This means that phase ampere turns exceed neutral ampere turns and an alternating magnetic flux results in the core. This flux links with the search coil which is also wound on the magnetic circuit, inducing an e.m.f. into it. The value of this e.m.f. depends on the residual current, so it will drive a current to the tripping system which depends on the difference between phase and neutral currents. When the amount of residual current, and hence of tripping current, reaches a pre-determined level, the circuit breaker trips, opening the main contacts and interrupting the circuit.

For circuit breakers operating at low residual current values, an amplifier may be used in the trip circuit. Since the sum of the currents in the phases and neutral of a three-phase supply is always balanced, the system can be used just as effectively with three-phase supplies. In high current circuits,

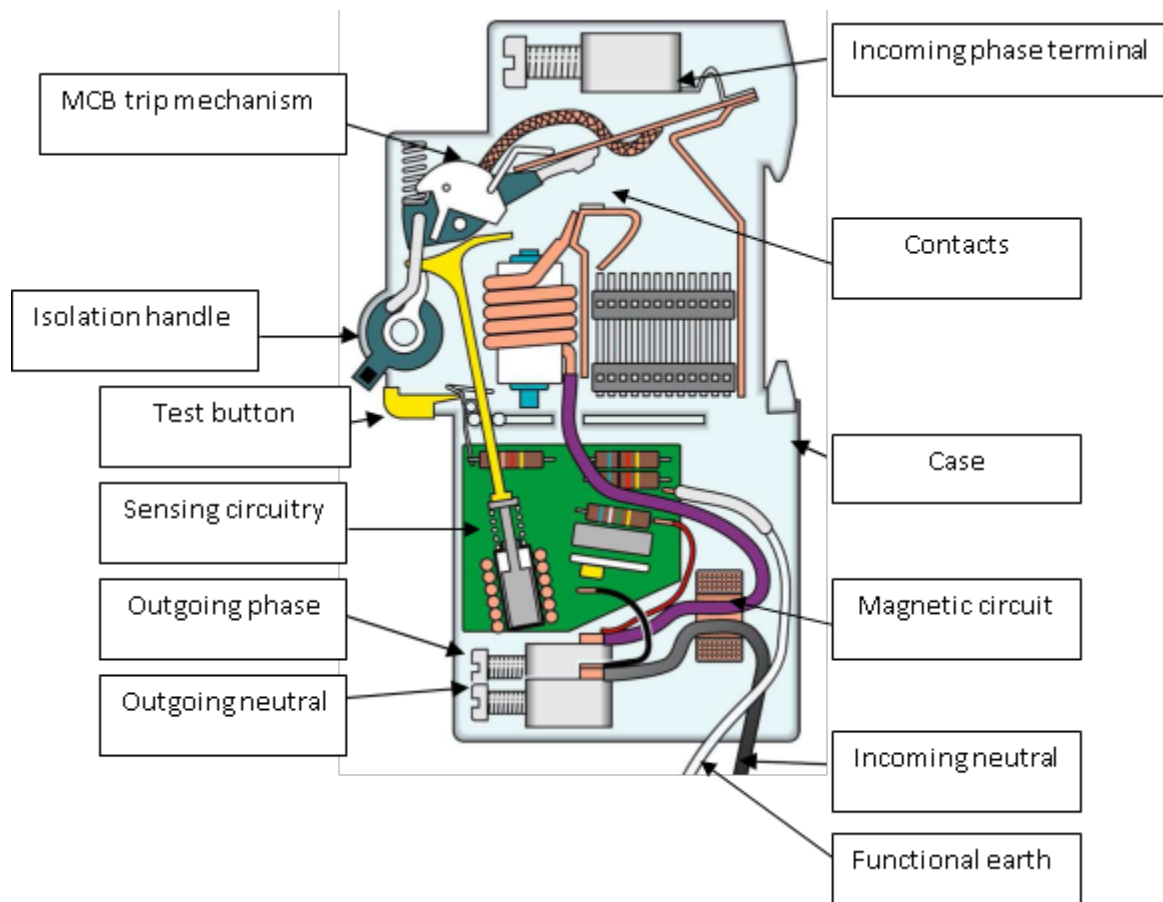
it is more usual for the phase and neutral conductors to simply pass through the magnetic core instead of round coils wound on it (extracted from *The Electricians Guide – Fifth Edition* by John Whitfield).

The device also has a test button which, when pressed, causes the rated level of residual current to ensure that the circuit breaker will operate to flow through the phase coil but bypasses the neutral coil. This current results in an imbalance in the current through the detection circuit causing the breaker to open.

Modern devices have been designed to be insensitive to surge currents up to the limits specified by the manufacturer.

The following diagram from Schneider Electric shows the typical internal configuration of the RCD:

**Configuration of typical RCD (from Schneider Electric)**



## 6 Purpose of the residual current device

The fundamental rule for protection against electric shock is that:

- hazardous live parts shall not be accessible, and
- accessible conductive parts shall not be hazardous
  - under normal operating conditions, and
  - under a single fault condition.

The normal protection measures against hazardous live parts include:

- protection by the insulation of live parts
- protection by means of barriers or enclosures
- protection by means of obstacles or placing out of reach
- protection by use of extra low voltage.

However, sometimes these preventative measures fail due to lack of maintenance, imprudence, carelessness, normal wear and tear, age or environmental effects.

Where electrical equipment is contained in an earthed metal box, any current leakage from the equipment is likely to flow in the earthed enclosure. This could lead to dangerous potential differences between that enclosure and other earthed metalwork which is also open to touch.

The main purpose of the RCD is to limit the severity of electric shock due to indirect contact.

This occurs when a person touches an exposed conductive part that is not normally live but has become live accidentally, due to some fault condition.

RCDs with a sensitivity of 30 mA are designed to monitor the residual current; operate; and disconnect the electrical supply, automatically clearing the fault with sufficient speed to prevent serious injury, fibrillation of the heart or death by electrocution of a normal healthy human being.

## **7 Effect of current through the body**

An electric shock is the pathophysiological effect of an electric current as it passes through the body. As the majority of the body is an aqueous electrolyte, any external electric current can flow relatively easily through the body once it has passed the skin barrier. The muscular, circulatory and respiratory systems are mostly affected by this current, but serious burns can also result. If the effects are sufficiently severe, death by electrocution could be the end result.

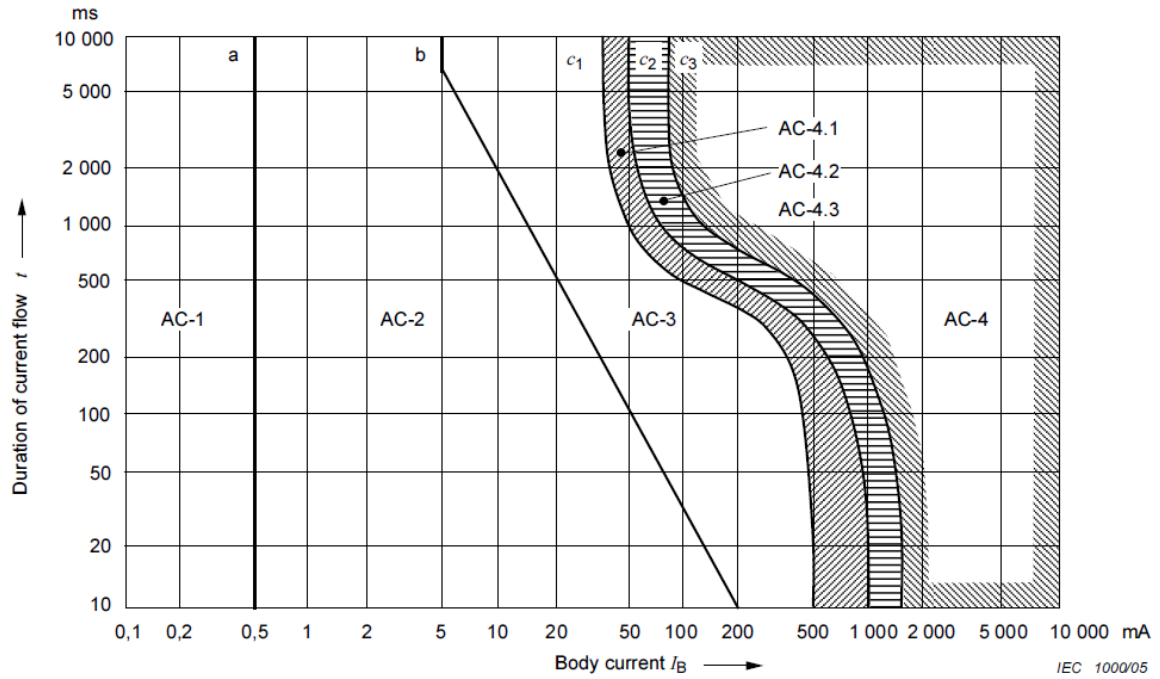
The degree of danger to which a person may be subjected depends on a number of parameters including:

- the magnitude of the current
- the duration of the current
- the current path through the body
- the age and health of the person
- the skin condition and area of contact with current source
- the body impedance
- the touch voltage
- the frequency of the current
- the occurrence of the shock in relation to the cardiac cycle.

A person who comes into contact with live metal risks getting an electric shock.

The following figure taken from AS/NZS 60479.1 provides the conventional time/current zones of the effects of alternating currents (between 15 Hz and 100 Hz) on persons for a current path corresponding to left hand to both feet.

**Figure 20 – Conventional time/current zones of effects of a.c. currents (15 Hz to 100 Hz) on persons for a current path corresponding to left hand to feet (for explanation see Table 11) (from AS/NZS 60479.1)**



The figure is divided into four distinct parts with increasing severity of effect on the body as the magnitude of the current increases from left to right.



The following table, also from AS/NZS 60479.1, provides the explanation of the zones, their boundaries and the physiological effects that can be expected when various body currents flow for the specified time durations.

**Table 11 – Time/current zones for a.c. 15 Hz to 100 Hz for hand to feet pathway – Summary of zones of Figure 20 (from AS/NZS 60479.1)**

Zones	Boundaries	Physiological effects
AC-1	Up to 0,5 mA curve a	Perception possible but usually no 'startled' reaction
AC-2	0,5 mA up to curve b	Perception and involuntary muscular contractions likely but usually no harmful electrical physiological effects
AC-3	Curve b and above	Strong involuntary muscular contractions. Difficulty in breathing. Reversible disturbances of heart function. Immobilization may occur. Effects increasing with current magnitude. Usually no organic damage to be expected
AC-4 <sup>1)</sup>	Above curve $c_1$  $c_1-c_2$  $c_2-c_3$  Beyond curve $c_3$	Patho-physiological effects may occur such as cardiac arrest, breathing arrest, and burns or other cellular damage. Probability of ventricular fibrillation increasing with current magnitude and time  AC-4.1 Probability of ventricular fibrillation increasing up to about 5 %  AC-4.2 Probability of ventricular fibrillation up to about 50 %  AC-4.3 Probability of ventricular fibrillation above 50 %
<sup>1)</sup> For durations of current flow below 200 ms, ventricular fibrillation is only initiated within the vulnerable period if the relevant thresholds are surpassed. As regards ventricular fibrillation, this figure relates to the effects of current which flows in the path left hand to feet. For other current paths, the heart current factor has to be considered.		

Generally then, AC-1 and AC-2 zones are expected to have little harmful effect, while AC-4 is expected to have major if not fatal effects on the body. Zone AC-3 provides what is considered to be the limits of acceptable body current and duration.

Taking two points on curve  $c_1$  as the limits:

- At the time of 5 s, maximum body current is approximately 35 mA
- At the time of 400 ms, maximum body current is approximately 140 mA.

The 30 mA value has been selected as the protection level for general purpose RCDs.

## 8 Maximum break times for residual current devices

Table 8.1 provides the maximum values of break times for a standard 30 mA RCD according to the various standards:

**Table 8.1 – Maximum values of break times for standard RCDs according to the various standards**

Standard	Leakage Current		
	30 mA	60 mA	150 mA
AS/NZS 3190	300 ms	150 ms	40 ms
AS/NZS 61008.1	300 ms	150 ms	40 ms
AS/NZS 61009.1	300 ms	150 ms	40 ms

The  $c_1$  curve of AS/NZS 60479.1 is the threshold before serious physiological effects are to be expected. RCDs have been designed such that the time/current activation points are much closer to the curve b than the curve  $c_1$  requiring tripping to be in the area where there should be less harmful effects should the leakage current pass through the body.

## 9 Limitations of RCDs

RCDs provide additional protection against electrocution that is already provided by insulation, barriers, obstacles, placing out of reach, electrical separation, automatic disconnection of supply, good earthing, fuses, circuit breakers and good circuit design including low earthing system impedance.

RCDs have been designed to monitor the vector difference in current between the phase and neutral. Consideration should be given as to whether the installation of the RCD will provide the particular additional protection that may be required in an application.

As with all electrical devices, RCDs have their limitations. Some are:

- 'Electrocute' is defined as 'to kill by electricity'. RCDs do not and cannot protect against electric shock but, given the right circumstances, can protect against electrocution.
- RCDs are not intended to replace conventional overcurrent protection as the primary means of protection against the effect of electric shock.
- RCDs cannot replace the long-established MEN protection system where reliance is placed on an effective and properly installed earthing system.
- RCDs can provide additional protection in areas where excessive leakage current in the event of failure of other protection devices could cause significant electrical risk. RCDs do not replace other forms of primary protection – they are in addition to these other measures. It is taken for granted that good electrical design has already been carried out and RCDs are added as appropriate to help lower residual risk.
- RCDs do not provide protection against phase to phase or phase to neutral faults, including arcing faults and short circuits (except where the short circuit is to earth).
- RCDs do not provide protection against overload.
- RCDs do not provide protection against voltages imported into the electrical installation earthing system through the supply system neutral conductor.
- RCDs do not protect against reverse polarity connections.
- RCDs may require upstream fault limiting protection.
- RCDs may not operate in very cold conditions or corrosive environments.
- RCDs cannot differentiate between current flow through an intended load and current flow through a person.
- The leakage current normally found in an electrical installation can cause nuisance tripping of RCDs. Examples:
  - current leakage as a result of the capacitance between live conductors and earth in electrical cabling installations (this can be minimised in wet underground installations by using appropriate cable such as XLPE/HDPE)

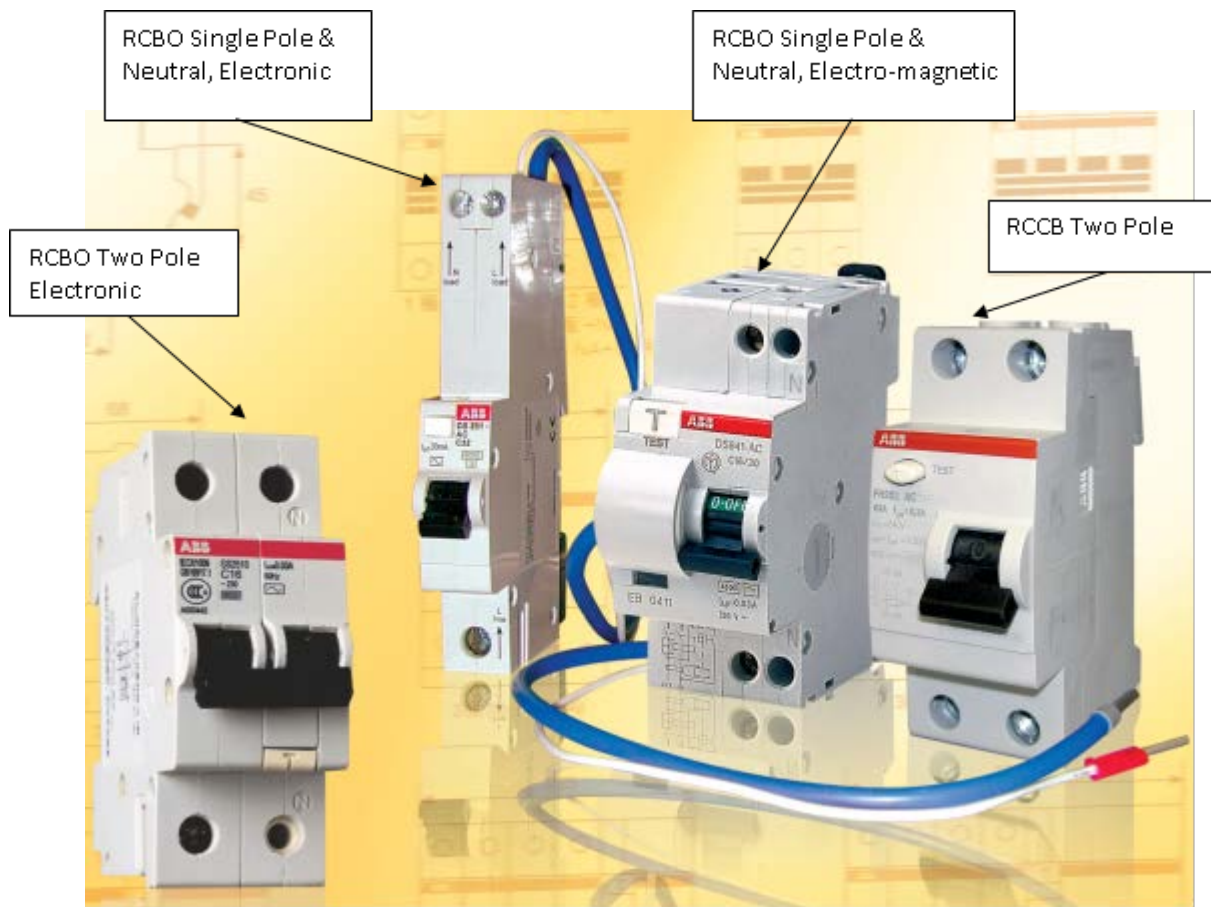
- current leakage as an integral part of the operation of some electrical equipment, such as fluorescent and HID luminaires and smoothing filters
- current leakage associated with high frequency currents flowing to earth through parasitic capacitances due to pulsed d.c.-type component in equipment such as switch mode power supplies of electronic equipment
- current leakage resulting from common mode over-voltages due to lightning strikes or distribution system switching, causing transient currents to flow to earth via the installation capacitance.
- The standard value of residual non-operating current for a 30 mA RCD is 15 mA. Manufacturers generally calibrate RCDs at  $22.5 \text{ mA} \pm 3 \text{ mA}$ . Nuisance tripping may therefore be more of a concern where there is high normal leakage current.
- RCDs are not recognised as a sole means of basic protection against contact with live parts but may be used in addition to insulation, barriers and obstacles.

## 10 Types of residual current devices

The types of RCDs generally available are:

- RCBOs – RCDs with integral overcurrent protection, generally in the form of a miniature circuit breaker
  - A particular subset of the RCBO is a circuit breaker and a separate residual current unit (commonly called RCD-blocks) which are assembled together on site to form one unit.
- RCCBs – RCDs without integral overcurrent protection which must be installed in series with a fuse or miniature circuit breaker
  - A particular subset of the RCCB is the RCD protected socket outlet. These generally can also protect other outlets connected downstream.
- The portable residual current device (PRCD) and the portable socket outlet assembly (PSOA) are not addressed in this document.
- Some RCDs have a relay with separate toroidal current transformer and are used with a separate tripping device.

**Types of residual current devices (from Residual Current Devices, Technical Data Sheet, ABB)**



## 11 Classes of residual current devices

RCDs are classified by their operating characteristics.

**Class AC devices:** Tripping is ensured for residual sinusoidal alternating currents, whether suddenly applied or slowly rising. This is the general, most widely used type for socket outlets and household appliances.

**Class A devices:** Tripping is ensured for residual sinusoidal alternating currents and for residual pulsating direct currents, whether suddenly applied or pulsating direct. This type is often used with computers and electronic equipment.

**Class B devices:** Tripping is ensured for residual sinusoidal alternating currents and for residual pulsating direct currents, whether suddenly applied or pulsating direct, for residual alternating currents up to 1000 Hz, for alternating currents or pulsating direct currents superimposed on a smooth direct current of 0.4 times the rated residual current, and for residual direct currents that may result from rectifying circuits. These are often used for three phase rectification circuits such as UPS and variable speed drives.

**Class S devices:** These RCDs have a built-in time delay corresponding to a given value of residual current, to provide discrimination. These will generally not be used.

## 12 Specifying a residual current device

When specifying the RCD, the following characteristics (with typical parameters) need to be selected and detailed for the particular application:

**Table 12 – Characteristics (with typical parameters) for RCCB and RCBO**

Characteristic	RCCB	RCBO
Type of installation	Fixed installation, fixed wiring	Fixed installation, fixed wiring
Rated voltage (Un)	240/415	240/415
Rated frequency (Hz)	50	50
Number of poles and current paths	Single pole RCCB with two current paths Two pole RCCB Three pole RCCB Three pole RCCB with four current paths Four pole RCCB	Single pole RCBO with one overcurrent protected pole and uninterrupted neutral Two pole RCBO with one overcurrent protected pole Two pole RCBO with two overcurrent protected poles Three pole RCBO with three overcurrent protected poles Three pole RCBO with three overcurrent protected poles and uninterrupted neutral Four pole RCBO with three overcurrent protected poles Four pole RCBO with four overcurrent protected poles
Rated current (A) (In)	10, 16, 20, 25, 32, 40, 63, 80, 100, 125	10, 16, 20, 25, 32, 40, 50, 63, 80, 100, 125
Rated residual operating current (mA)	30	30
Rated making & breaking capacity (kA)	3, 4.5, 6, 10	3, 4.5, 6, 10
Operating characteristic with d.c.	AC, A, B	AC, A, B
Tripping characteristic		B, C
Time delay	With, without	With, without
Mounting method	DIN rail	DIN rail

### NOTES:

- The residual current is the vector difference between phase and neutral currents. This will be the 30 mA.
- The rated current is current carrying capacity of the device in normal operation, typically 16 A, and is the maximum demand load of the circuit or the rating of the overload protective device of the circuit.
- The rated making and breaking capacity of the device is the fault current that the contacts can close onto or open and break. This will depend on the available prospective short circuit current, typically 6 kA, and needs to be calculated at the point where the RCD is to be installed.
- The possible waveform of a fault current to earth caused by various types of electronic equipment can affect the operation of RCDs and must be taken into account when selecting the type of RCD.
- Good quality RCDs have high immunity to nuisance tripping caused by high frequency and transient currents.

- Manufacturer's data should be referred to when specifying RCDs to ensure the appropriate parameters are selected for the application.

### 13 Installing a residual current device

The RCD must be installed upstream of the equipment or part of the circuit it is required to protect and downstream of any MEN point. Because the RCD is detecting imbalance in the phase and neutral currents, upstream of the MEN the neutral is carrying both the neutral and the earth currents and so the RCD is not likely to function in the manner for which it was designed.

The manufacturer's instructions must be followed when installing the RCD.

### 14 Testing a residual current device

RCDs are electro-mechanical devices having moving parts that can become stiff with age or contaminants. As such, the RCD requires regular activation to ensure that it operates correctly.

Using the test button on the RCD establishes:

- the RCD is functioning correctly
- the integrity of the electrical and mechanical elements of the tripping device.

However, this test does not provide a means of checking:

- the continuity of the main earthing conductor or the associated circuit protective earthing conductors
- any earth electrode or other means of earthing
- any other part of the associated electrical installation earthing.

It is recommended that testing of the RCD for correct operation is carried out at least annually by pressing the test button. More frequent testing may be required, depending on the application. Other tests may be required in accordance with the manufacturer's recommendations.

NOTE: Testing the RCD disconnects power to the downstream equipment for the duration of the test until the RCD has been reset.

NOTE: Where RCDs are not installed, earth fault loop impedance tests must be carried out.

### 15 Where residual current devices are required

The requirements for additional protection by RCDs are included in clauses 1.5.6.3 and 2.6 (in particular, 2.6.3.2) of AS/NZS 3000:2007.

#### 2.6.3.2 Other electrical installations

##### 2.6.3.2.1 Australia

NOTE:

1 This clause specifies particular equipment that must be protected by RCDs:

*(a) final subcircuits supplying socket-outlets where the rated current of any individual socket-outlet does not exceed 20 A; and*

*(b) final subcircuits supplying lighting where any portion of the circuit has a rated current not exceeding 20 A; and*

*(c) final subcircuits supplying directly connected hand-held electrical equipment, e.g. hairdryers or tools.*

Part (c) addresses hand-held directly connected equipment such as hairdryers and hand tools. These are high risk items as the connecting power lead is subjected to continual flexing and is seldom maintained.

2 RCDs may not be installed:

*5 Where the disconnection of a circuit by an RCD could cause a danger greater than earth leakage current.*

*6 Where all socket-outlets on a final subcircuit are installed for the connection of specific items of equipment, provided that— ...*

3 RCDs must be installed in departmental installations in accordance with AS/NZS 3000.

However, where the disconnection of the circuit by the RCD could cause a danger greater than the earth leakage current, or where all the provisions for specified items of equipment can be met, RCDs may not be required.

4 Where RCDs are installed for additional protection on specific equipment, only that equipment should be connected to the RCD – one RCD, one circuit.

## **16 AS/NZS 3000 Part 2 Exceptions**

### **16.1 General comments**

The *Electrical Safety Act 2002* requires that an electrical installation be electrically safe, which means that the electrical risk to the person or property is as low as reasonably achievable, having regard to the likelihood of harm and likely severity of harm. (ESA 10 (4)).

AS/NZS 3000:2007 Clause 1.1 states that guidance is provided so that the electrical installation will function correctly for the purpose intended.

The intent of these documents is that electrical installations are fit for purpose and function with a reasonably low level of risk. It is within this framework that particular applications of RCDs within the departmental infrastructure are considered.

### **16.2 AS/NZS 3000 Clause 2.6.3.2.1 Exception 5**

To determine whether the disconnection of the RCD through nuisance tripping could cause a danger/risk greater than the earth leakage current, in accordance with AS/NZS 3000:2007 Clause 2.6.3.2.1 Exception 5, a risk assessment must be carried out. This should follow the principles of *Electrical Safety Code of Practice 2010 – Risk Management*.

A general risk assessment has been carried out for a number of electrical installations to determine if this exception could apply. This assessment is included in Appendix B.

These consider the risk to a person from vehicular or criminal activity compared with the risk to a person from an electrical installation, using the parameters of the likelihood of harm and likely severity of harm.

### **16.2.1 Road lighting installations**

From the risk analysis, road lighting installations are considered to comply with the requirements of Exception 5.

### **16.2.2 Traffic signals installations**

From the risk analysis, traffic signals installations are considered to comply with the requirements of Exception 5.

### **16.2.3 Pathway lighting installations**

From the risk analysis, pedestrian pathway lighting installations to AS/NZS 1158 are considered to comply with the requirements of Exception 5.

### **16.2.4 Safety related traffic management devices**

From the risk analysis, safety related traffic management devices are considered to comply with the requirements of Exception 5.

## **16.3 AS/NZS 3000 Clause 2.6.3.2.1 Exception 6**

### **16.3.1 Essential equipment**

Essential equipment may come under Exception 6 of AS/NZS 3000:2007 Clause 2.6.3.2.1 provided all of the following specified requirements are complied with:

*Exception 6: Where all socket-outlets on a final subcircuit are installed for the connection of specific items of equipment, provided that—*

Comment: The socket outlets are used to connect specific ITS equipment or systems.

*(a) the connected equipment 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; and*

Comment: The equipment is essential and loss of functionality of that equipment as a result of tripping of the RCD would adversely affect the operation of the system.

*(b) the connected equipment is designed, constructed and used in such a manner that is not likely to present a significant risk of electric shock; and*

Comment: The equipment is double insulated or effectively earthed and work procedures are in place concerning the use of the equipment without RCD protection.

*(c) the socket-outlet is located in a position that is not likely to be accessed for general purposes; and*

Comment: Unprotected socket outlets are for specific essential equipment only and must be separated from general purpose outlets. General purpose outlets must be RCD protected.

*(d) the socket-outlet is clearly marked to indicate the restricted purpose of the socket-outlet and that RCD protection is not provided.*

Comment: All non-RCD protected socket outlets must be clearly labelled.



## **17 Discussion**

A number of other installations were also reviewed.

### **17.1 Lift sump pumps**

With the exception of lighting circuits, directly connected equipment is not required to have RCD protection. Provided lift sump pumps are directly connected to a local isolator and are not connected to a socket outlet, there is no requirement for RCD protection. The sump pumps are located away from the public area, a key is required for access and authorised personnel are used to service the equipment.

### **17.2 Busway platform stairway lighting**

Busway platform stairway lighting circuits and other building lighting including under soffit platform lighting must be protected by RCDs. This is standard industry practice for buildings.

Luminaires must be selected so they are suitable for the application. Where they are exposed to weather or in a polluted environment, they must be rated minimum IP65 to minimise ingress of moisture, dust and vermin that could result in nuisance tripping of the RCD.

At least two lighting circuits must be provided. Luminaires must be connected evenly across the circuits and located suitably such that in the event of RCD tripping, no area is without appropriate lighting.

Circuits supplying single point, integral battery, emergency and exit lighting must be monitored such that an alarm is raised when the circuit is not live.

### **17.3 Tunnel pedestrian egress lighting**

Note: Pedestrian underpass lighting is classified as pathway lighting and not tunnel lighting.

Generally, tunnel pedestrian egress lighting is considered to be under the same criteria as busway platform stairway lighting and requires RCD protection. However, where power to this lighting is supplied from a central system in accordance with AS/NZS 2293.1, RCDs must not be incorporated into the lighting circuits.

### **17.4 Non-safety related systems**

There are a number of systems installed in the roadway that are not directly related to traffic safety. These include such items as webcams, traffic survey sites, travel time signs, parking guidance systems, advertising signs and billboards. These must comply with the RCD requirements of AS/NZS 3000.

## Appendix A – Risk assessment tables

The following tables have been extracted from *Electrical Safety Code of Practice 2010 – Risk Management*.

**Table A1 – Risk priority chart**

Likelihood How likely is it to happen?	Consequences How severely it hurts someone (if it happens)?				
	Insignificant (I)	Minor (Mi)	Moderate (Mo)	Major (Ma)	Catastrophic (C)
Almost certain (A)	3 H	3 H	4 A	4 A	4 A
Likely (L)	2 M	3 H	3 H	4 A	4 A
Possible (P)	1 L	2 M	3 H	4 A	4 A
Unlikely (U)	1 L	1 L	2 M	3 H	4 A
Rare (R)	1 L	1 L	2 M	3 H	3 H

**Table A2 – Risk score and statement**

Score and statement	Action
4 A: Acute	ACT NOW – Urgent – do something about the risk immediately. Requires immediate action.
3 H: High	Highest management decision is required urgently.
2 M: Moderate	Follow management instruction.
1 L:Low	OK for now. Record and review if any equipment/people/materials/work processes or procedures change.

### Likelihood

Likelihood is the product of the probability that a hazard will occur, based on historical experience, and the time of exposure to that hazard. This is determined as shown in this table:

**Table A3 – Likelihood descriptive scale**

Likelihood	Frequency	Description
Almost certain	Once per day to one week	The hazard is expected to occur in most circumstances
Likely	Once per week to one month	The hazard will probably occur in most circumstances
Possible	Once per month to one year	The hazard will probably occur in some circumstances
Unlikely	Once in one to five years	The hazard could occur at some time but unlikely
Rare	Once in five to ten years	The hazard may occur only in very exceptional circumstances

### Consequence

Consequence is the most probable outcome of exposure to the hazard. This is determined as shown in this table:

**Table A4 – Consequence descriptive scale**

Consequence	Description
Severe	Fatality, loss of limb. Extensive damage to equipment or public services. Major incident.
Major	Extensive injuries requiring hospitalisation. Equipment damage extensive and insurance claim required. May involve members of the public.
Moderate	Medical treatment required for injuries and lost time recorded. No hospitalisation. Equipment damage costs below insurance claim amount.
Minor	First aid/casualty treatment. Minor damage to equipment.
Insignificant	No injury. No damage to equipment.

## Appendix B – Risk assessment for particular installations

**Table B1 – Road lighting**

Area of risk	Description of risk	Mitigation of risk	Risk assessment			Comments
			L	C	R	
<b>Road lighting,</b> (including tunnel road lighting and busway road median lighting)	Electric shock due to person coming in contact with metal pole during a fault (e.g. road crash)	Rate 3 road lighting is energised only at night time. Standard design requires compliance with AS/NZS 3000 including 400 ms disconnect time for final subcircuit to pole. Maintenance practices require periodic verification of road lighting installations.	U	Mi	L	AS/NZS 3000 specifies a 5 s disconnect time for final subcircuits supplying fixed equipment. The 400 ms disconnect time reduces the risk of electric shock.
	Death or serious injury due to road incident as a result of road lighting being inoperative because of nuisance tripping of RCD	No mitigation – install RCD	A	C	A	In one eighteen-month period there were three fatalities on Qld roads where failure of the road lighting was an alleged contributing cause. Road lighting is a recognised aid to reducing traffic accidents. HID luminaires will have leakage current dependent on age and accumulation of environmental factors. Underground cables have normal leakage current due to capacitive effects. Risk of nuisance tripping of RCDs is high with consequent failure of the installation to meet its intended purpose.
<b>Conclusion</b>	Road lighting installations meet the requirements of AS/NZS 3000:2007 2.6.3.2.1 Exception 5. Departmental road lighting installations are required to comply with AS/NZS 3000. The specific deemed-to-comply requirement for additional RCD protection on lighting circuits in 2.6.3.2.1.(b) is not applied as the risk due to the disconnection of a circuit by an RCD through nuisance tripping could cause a danger/risk greater than earth leakage current. The fundamental safety principles of AS/NZS 3000 Part 1 however, are satisfied.					

**Table B2 – Traffic signals**

Area of risk	Description of risk	Mitigation of risk	Risk assessment			Comments
			L	C	R	
Traffic signals	Electric shock due to person coming in contact with metal traffic signal post during a fault (for example, road crash)	Standard design requires compliance with AS/NZS 3000 including 400 ms disconnect time for final subcircuit to pole. Maintenance practices require periodic verification of traffic signal installations.	U	Mi	L	AS/NZS 3000 specifies a 5 s disconnect time for final subcircuits supplying fixed equipment. The 400 ms disconnect time reduces the risk of electric shock.
	Death or serious injury due to road incident as a result of traffic signals being inoperative because of nuisance tripping of RCD	No mitigation – install RCD	L	Ma	A	Traffic signal lanterns are part of a traffic safety system. They will have leakage current dependent on age and accumulation of environmental factors. Underground cables have normal leakage current due to capacitive effects. Risk of nuisance tripping of RCDs is high with consequent failure of the installation to meet its intended purpose of safely managing traffic.
Conclusion	Traffic signals installations meet the requirements of AS/NZS 3000:2007 2.6.3.2.1 Exception 5. Departmental traffic signals installations are required to comply with AS/NZS 3000. The specific deemed-to-comply requirement for additional RCD protection on lantern circuits in 2.6.3.2.1.(b) is not applied as the risk due to the disconnection of a circuit by an RCD through nuisance tripping could cause a danger/risk greater than earth leakage current. The fundamental safety principles of AS/NZS 3000 Part 1 however, are satisfied. NOTE: Any socket outlets installed in the controller cabinet must have RCD protection.					

**Table B3 – Pedestrian pathway lighting**

Area of risk	Description of risk	Mitigation of risk	Risk assessment			Comments
			L	C	R	
<b>Pedestrian pathway lighting to AS/NZS 1158</b> (including exterior pathway lighting around bus stations, along bicycle ways, through park areas, carparks, etc.)	Electric shock due to person coming in contact with metal pole during a fault	Rate 3 pedestrian pathway lighting is energised only at night time. Standard design requires compliance with AS/NZS 3000 including 400 ms disconnect time for final subcircuit to pole. Maintenance practices require periodic verification of road lighting installations.	U	Mi	L	AS/NZS 3000 specifies a 5 s disconnect time for final subcircuits supplying fixed equipment. The 400 ms disconnect time reduces the risk of electric shock.
	Assault, serious injury or death due to criminal activity as a result of pedestrian pathway lighting being inoperative because of nuisance tripping of RCD	No mitigation – install RCD		P	Ma	A
<b>Conclusion</b>	Pedestrian pathway lighting installations meet the requirements of AS/NZS 3000:2007 2.6.3.2.1 Exception 5. Departmental pathway lighting installations are required to comply with AS/NZS 3000. The specific deemed-to-comply requirement for additional RCD protection on lighting circuits in 2.6.3.2.1.(b) is not applied as the risk due to the disconnection of a circuit by an RCD through nuisance tripping could cause a danger/risk greater than earth leakage current. The fundamental safety principles of AS/NZS 3000 Part 1 however, are satisfied.					

**Table B4 – Safety related traffic management devices**

Area of risk	Description of risk	Mitigation of risk	Risk assessment			Comments
			L	C	R	
<b>Safety related traffic management devices</b> (including electronic speed limit signs (ESLS), variable message signs (VMS) and enhanced variable message signs (EVMS), lane use management systems (LUMS), road condition information signs (RCIS), overhead vehicle detection systems, conspicuity devices such as flashing wigwags, ramp metering, CCTV)	Electric shock due to person coming in contact with metal parts of equipment during a fault	Standard design requires compliance with AS/NZS 3000 including 400 ms disconnect time for final subcircuit to pole. Maintenance practices require periodic verification of safety related traffic management installations.	U	Mi	L	AS/NZS 3000 specifies a 5 s disconnect time for final subcircuits supplying fixed equipment. The 400 ms disconnect time reduces the risk of electric shock.
	Death or serious injury due to road incident as a result of safety related traffic management devices being inoperative because of nuisance tripping of RCD	No mitigation – install RCD	L	Ma	A	Safety related traffic management devices are designed to help improve the safety of vehicle and pedestrian users of the road system. They are expected to have leakage current dependent on age, and accumulation of environmental factors. Underground cables have normal leakage current due to capacitive effects. Risk of nuisance tripping of RCDs is high with consequent failure of the installation to meet its intended purpose of safely managing traffic.
<b>Conclusion</b>	Safety related traffic management devices meet the requirements of AS/NZS 3000:2007 2.6.3.2.1 Exception 5. Safety related traffic management devices are required to comply with AS/NZS 3000. The specific deemed-to-comply requirement for additional RCD protection on these circuits in 2.6.3.2.1.(b) is not applied as the risk due to the disconnection of a circuit by an RCD through nuisance tripping could cause a danger/risk greater than earth leakage current. The fundamental safety principles of AS/NZS 3000 Part 1 however, are satisfied.					

