BRANZ

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RECESSED DOWNLIGHTS (LUMINAIRES)

February 2020

- LED technology has undergone significant changes in the past few years, making them an energy-efficient and cost-effective form of lighting as recessed luminaires.
- Retrofitting LED lamps into existing fittings can be done, but a better option may be to replace the luminaire.
- This bulletin describes the classifications of recessed luminaires, their legislative and installation requirements and the range of lamps available. It replaces Bulletin 539 *Recessed downlights*.

1 INTRODUCTION

1.0.1 Recessed downlights (recessed luminaires) are a popular lighting choice for residential lighting as they provide an uncluttered ceiling surface, hide any ceiling imperfections because the light does not shine directly across it and generally result in little or no glare.

1.0.2 In recent years, recessed luminaire technology and use of LED lamps has undergone significant changes. This has implications for the buildings in which they are installed with regard to thermal efficiency, overheating and air and moisture movement. As a result, recessed luminaires have become a more useable form of lighting.

1.0.3 A recessed luminaire is a luminaire or apparatus that is recessed into a mounting surface, typically a ceiling, and distributes light produced from a lamp.

1.0.4 As luminaires recessed into a ceiling direct most of their light downwards in a wide or narrow spread depending on beam angle, little light is reflected onto the walls or ceiling.

1.0.5 The early recessed luminaires used large fittings with incandescent lamps that generated a considerable amount of heat. This meant the insulation and the building elements in the ceiling space had to be kept well clear of the fittings, significantly compromising the R-value of the insulation and resulting in both heat loss and a route for air and moisture to migrate from the space below into the ceiling space.

1.0.6 When compact fluorescent lamps (CFLs) were introduced, they were often used to replace incandescent lamps but the CFLs did not solve all the issues.

1.0.7 Halogen lamps were introduced in the late 1980s. Both lamps and fittings were smaller, and they quickly became popular. Halogen lamps produce more heat for their size than incandescent lamps so they did not diminish the issues of heat loss. The higher temperatures generated also meant there was a greater fire risk if they were not installed correctly, and the air and moisture migration remained an issue.

1.0.8 The development of low heat-producing LED lamps in sealed units means that recessed luminaires may be covered by insulation, significantly reducing the issues related to heat loss and air and moisture movement.

1.0.9 This bulletin describes the classifications and installation requirements and the types of lamps for recessed luminaires. It also describes the requirements for retrofitting LED lamps into existing fittings originally intended for other types of lamps.

1.0.10 Although recessed luminaires may be installed in walls and floors, this bulletin focuses on ceiling recessed luminaires in residential dwellings. It replaces Bulletin 539 *Recessed downlights*.

2 LEGISLATION

2.0.1 All lighting, including recessed luminaires, must comply with the relevant clauses of the New Zealand Building Code.

2.0.2 The clauses that affect the installation of recessed luminaires are:

- B2 *Durability*
- C *Fire safety*
- E3 *Internal moisture*
- G8 *Artificial light*
- G9 *Electricity*
- H1 *Energy efficiency*.

2.1 B2 *DURABILITY*

2.1.1 Under Acceptable Solution B2/AS1, recessed luminaires must have a minimum durability of 5 years.

2.2 C *FIRE SAFETY*

2.2.1 Acceptable Solution C/AS2 references AS/NZS 60598.2.2:2001 *Luminaires – Part 2.2: Particular requirements – Recessed luminaires*. It requires that recessed luminaires in risk group SM (multiple sleeping buildings such as apartments, hotels, halls of residence, wharenui and other community sleeping spaces and sheltered housing) must only be of the types classified in accordance with AS/NZS 60598.2.2:2001.

2.3 E3 *INTERNAL MOISTURE*

2.3.1 Acceptable Solution E3/AS1 requires that a minimum ceiling R-value of R1.5 must be maintained.

2.4 G8 *ARTIFICIAL LIGHT*

2.4.1 Acceptable Solution G8/AS1 contains the comment: "Downlights and other luminaires with concentrated or narrow beam distribution, require particular care with spacing, if minimum illuminance criteria are to be met."

2.5 G9 *ELECTRICITY*

2.5.1 Acceptable Solution G9/AS1 references AS/NZS 3000:2007 *Electrical installations (known as the Australian/New Zealand Wiring Rules)*. It also references NZECP 54:2001 *New Zealand electrical code of practice for the installation of recessed luminaires and auxiliary equipment*. NZECP 54:2001 has been superseded, but it has not been withdrawn from the New Zealand legislative framework.

2.6 H1 *ENERGY EFFICIENCY*

2.6.1 Clause 1.3.5 of H1 (the performance requirement of H1) requires that artificial lighting fixtures must be located and sized to limit energy use.

2.6.2 The BRANZ House Insulation guide, fifth edition, provides some graphs that show the loss of ceiling insulation when using downlights that cannot be covered with insulation.

When there is more than one uncovered downlight per three square metres of ceiling, the value of the ceiling insulation can be reduced below the code minimum.

2.7 CITED LEGISLATION IN THE ACCEPTABLE SOLUTIONS HAS NOT BEEN UPDATED

2.7.1 The standards AS/NZS 60598.2.2:2001 and AS/NZS 3000:2007 that are cited in the Acceptable Solutions have been replaced by AS/NZS 60598.2.2:2016 and AS/NZS 3000:2018 respectively, but at the time of writing this bulletin, neither of the earlier standards have been withdrawn.

2.7.2 AS/NZS 60598.2.2:2016 introduced modifications to the terminology, temperature ratings and luminaire marks for both residential and commercial installations. When introduced, the standard was to have a 2-year introductory period and become mandatory in February 2018, but until the Electricity (Safety) Regulations 2010 recognise the 2018 edition of AS/NZS 3000, this update does not apply to New Zealand.

2.7.3 It is expected that AS/NZS 3000:2018 will be adopted into the Electrical (Safety) Regulations 2010 to replace the 2007 standard in late 2019, and a 12-month transition to the 2018 edition will probably be applied.

2.7.4 As AS/NZS 60598.2.2:2001 including Amendment A is currently the cited standard, it is also still applicable.

2.7.5 NZECP 54:2001 is also cited despite the classifications given for recessed luminaires, the methods of installation and clearance requirements all being out of date.

3 RECESSED LUMINAIRE CLASSIFICATIONS

3.0.1 Recessed luminaires are classified according to whether they may be covered by insulation (IC or insulation contact), may abut insulation (CA or close abutted) or must have a minimum clearance from insulation and building elements.

3.0.2 Recessed luminaires must also have a marking or symbol indicating the application.

3.0.3 Classifications and markings for recessed luminaires are given in AS/NZS 60598.2.2:2001 and AS/NZS 3000:2018, but the classifications are somewhat different. The differences are summarised in Table 1. As AS/NZS 60598.2.2:2001 is currently the cited standard, the classifications, markings and clearance distances in the standard apply in New Zealand.

3.0.4 Recessed luminaires must be tested in accordance with the standard, and manufacturers and suppliers must provide instructions including specific dimensions for clearances to building elements.

3.0.5 Due to the disparity of the classifications, markings and clearances in the standards, in order to meet the requirements of AS/NZS 60598.2.2:2001, New Zealand suppliers of recessed luminaires must make a supplier declaration of conformity (SDoC) and provide an accompanying mark and instructions on attaching the mark to the fitting until the regulations are updated.

3.0.6 Luminaires that do not have an identified classification:

- under AS/NZS 3000:2007, must be installed within a suitable enclosure or with the default clearances specified in the standard
- under AS/NZS 3000:2018, must be treated as 'Do-not-cover' fittings and must be installed with appropriate barriers or clearances as specified by the manufacturer or the default clearances specified in the standard.

3.0.7 AS/NZS 3000:2018 also requires that:

- where recessed luminaires are retrofitted and insulation is already installed, the insulation must not be compromised
- where clearances are to be applied but insulation has not yet been installed, a fire-resistant barrier or guard must be installed to ensure the required clearance is maintained (see Figure 1)
- unless instructions permit otherwise, auxiliary equipment should be installed above the insulation
- where insulation is to be retrofitted, the insulation installer must take precautions including ensuring

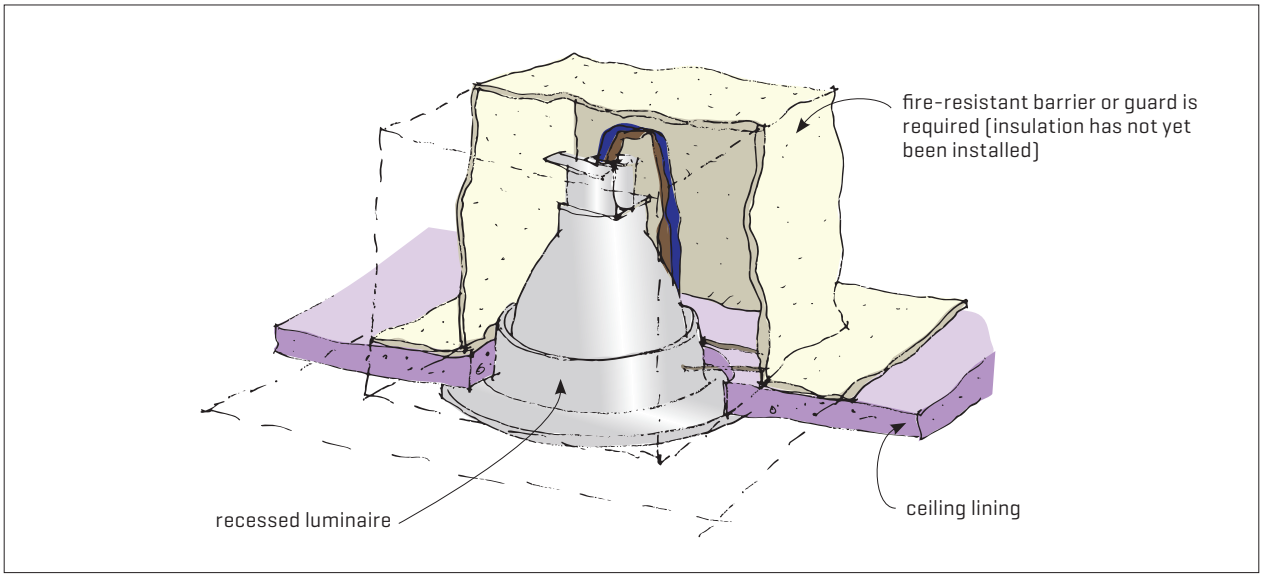
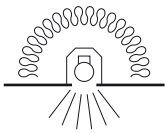
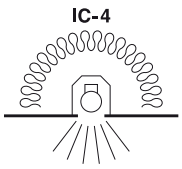
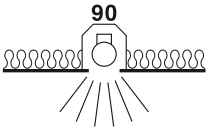
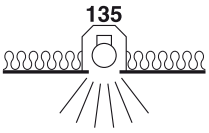
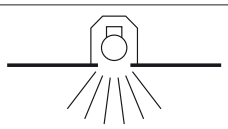
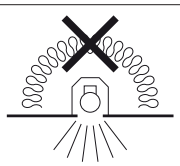


Figure 1. A recessed luminaire with a fire-resistant barrier or guard.

Table 1. Classifications and markings for recessed luminaires.

Symbol	Classification of recessed luminaires		Comments
	AS/NZS 60598.2.2:2001	AS/NZS 3000:2018	
	IC		Insulation that can be continuously exposed to 90°C may abut and cover the luminaire.
		IC	Normally flammable materials including insulation may abut and cover the luminaire in normal use.
	IC-F		Insulation that can be continuously exposed to 90°C may abut and cover the luminaire.
		IC-4	Normally flammable materials including insulation may abut and cover the luminaire in normal use. The unit is effectively sealed with restricted airflow between the habitable space being lit and the void/space where most of the luminaire is located.
	CA80		Insulation that can be continuously exposed to 90°C may abut the luminaire.
		CA90	Normally flammable materials including insulation may abut the luminaire in normal use.
	CA135		Insulation that can be continuously exposed to 150°C may abut the luminaire.
		CA135 (New Zealand only)	Normally flammable materials including insulation may abut the luminaire in normal use.
	Non-IC		Not suitable for covering or abutting with building insulation.
		Non-IC (must not be installed in residential installations)	Cannot be abutted against or covered by normally flammable materials.
		Do-not-cover (must not be installed in residential installations – New Zealand only)	May be used where normally flammable materials are present but must not be abutted against or covered.

that generated heat can be dissipated to prevent overheating and providing the required clearances.

3.1 IC VERSUS IC-F

3.1.1 Under AS/NZS 60598.2.2:2001, an IC-rated luminaire means that building insulation that can be continuously exposed to 90°C can safely abut and cover the luminaire.

3.1.2 In Amendment A (applicable to New Zealand only), an IC-F classification is also included. An IC-F marked downlight is described as an "IC-F (Insulation Contact – Fire resistant) recessed luminaire" and was included in the standard at the request of the insulation industry, which was concerned that some types of insulation might ignite if they came in contact with heated parts of the luminaire. The IC-F classification means that insulation can be continuously exposed to 90°C and can safely abut and cover the luminaire.

3.1.3 An IC-F rated downlight must also pass a 1.0 mm probe test. The test requires that a 1.0 mm diameter probe cannot enter any part of the luminaire and is intended to ensure that no insulation or any other material can enter the fitting.

3.1.4 As Amendment A was written primarily to deal with the heat issues of incandescent, halogen and CFL luminaires, the advent of LED downlights with their cooler operating temperatures means that most will comply with the IC-F classification.

3.2 FIRE-RATED LUMINAIRES

3.2.1 A fire-rated luminaire (usually rated 30/60 and 90 minutes) refers to the minimum time a downlight can maintain a barrier between the room and the ceiling space during a fire. To obtain a fire rating, a downlight has to undergo extensive (and expensive) testing.

4 INSTALLATION REQUIREMENTS GENERALLY

4.0.1 Recessed luminaires must have an installation classification that is marked on the fitting.

4.0.2 Unmarked fittings must be considered to have a 'Do-not-cover 'classification and may not be installed in residential buildings.

4.0.3 All recessed luminaires must be installed to minimise an excessive rise in temperature of the luminaire and the auxiliary equipment and prevent a risk of fire occurring from the ignition of combustible materials.

4.0.4 Separation from thermal insulation and combustible building materials must be in accordance with the manufacturer's recommendations or default clearances as given in AS/NZS 3000:2007 (see Figures 2 and 3).

4.0.5 Recessed luminaires and the auxiliary equipment must be installed in accordance with the insulation clearances described in NZS 4246:2016 *Energy efficiency – Installing bulk thermal insulation in residential buildings*.

4.0.6 Unless otherwise specified by the manufacturer, the area above the recessed luminaire must be kept clear of insulation, combustible materials or anything that could impede heat dissipation.

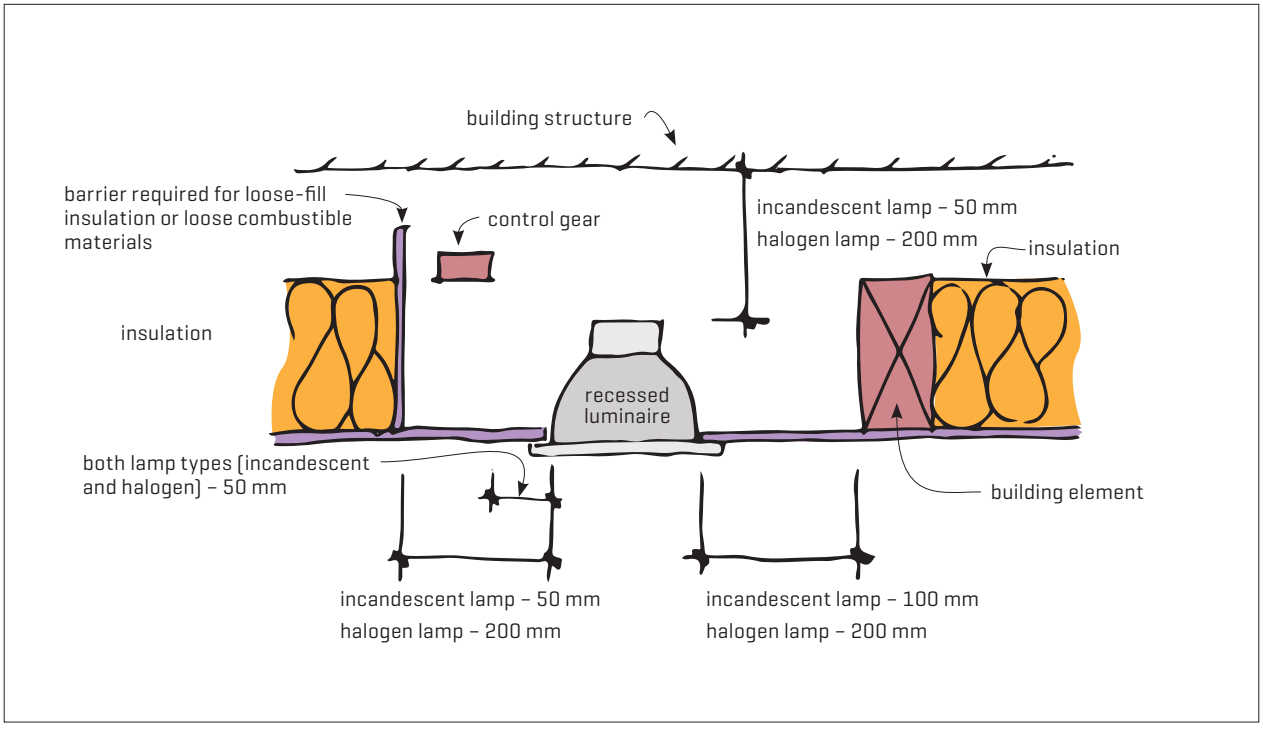


Figure 2. Default minimum clearances for recessed luminaires as per AS/NZS 3000:2007 Figure 4.7.

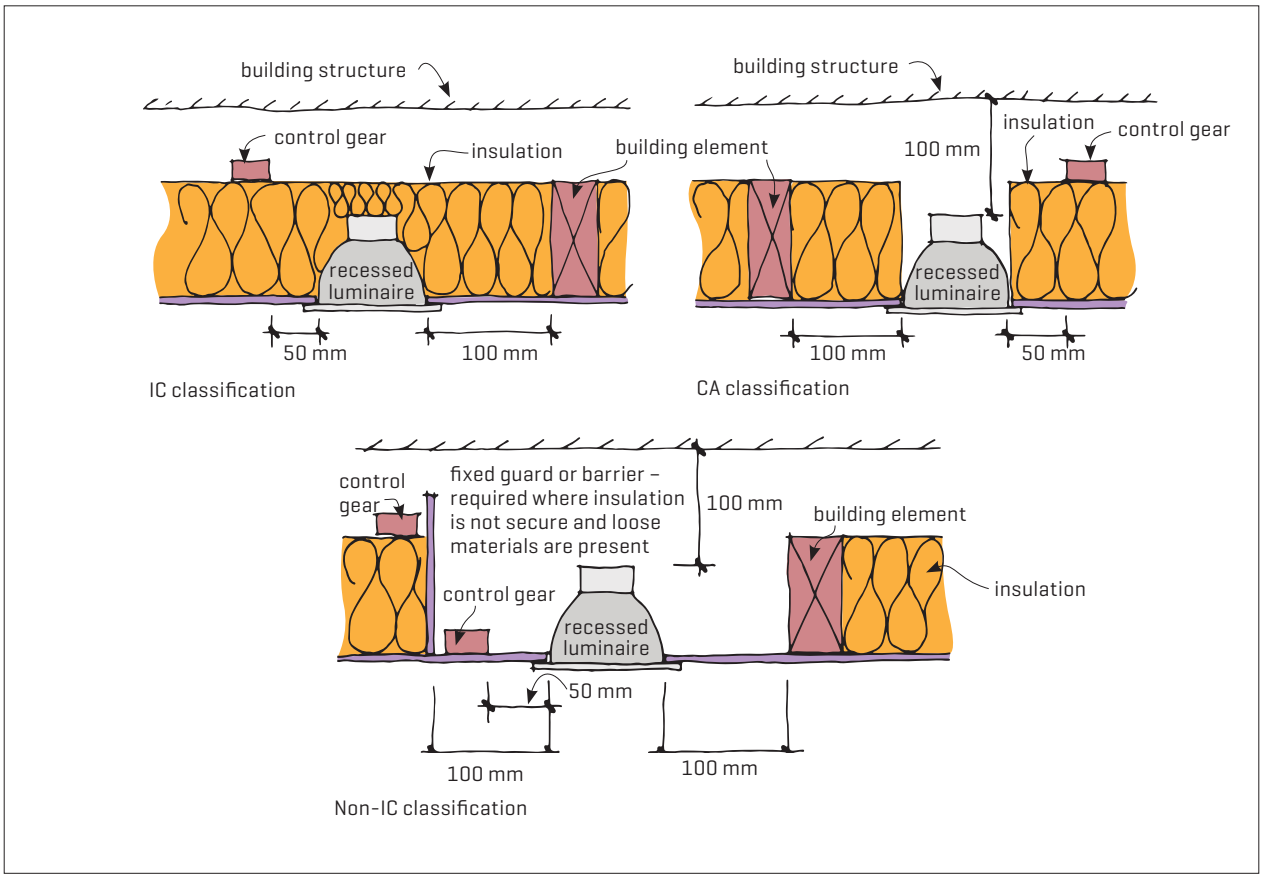


Figure 3. Default minimum clearances for recessed luminaires as per AS/NZS 3000:2018 Figure 4.9.

4.1 WARNING LABELS IN ROOF SPACE

4.1.1 Under AS/NZS 3000:2018, warning labels must be provided in accessible roof spaces where recessed downlights are installed except where the recessed luminaires are IC or IC-4 classification (see Figure 4).

4.2 RETROFITTING

4.2.1 When retrofitting, adding or altering recessed luminaires where building insulation is already installed, the safety of the installation must not be compromised (nor may the insulation value of the insulation).

4.3 REGULATORY COMPLIANCE MARK (RCM)

4.3.1 In order to comply with the Radiocommunications Act 1989 and its regulations and the Electrical (Safety) Regulations 2010, electrical and electronic products in New Zealand, including recessed luminaires, must display a compliance label that shows they may safely be used in New Zealand. The compliance mark recognised in New Zealand for electrical and electronic products is the regulatory compliance mark (RCM). This mark demonstrates compliance with both electrical safety and electromagnetic compatibility (EMC) requirements (see Figure 5).

5 LAMPS

5.0.1 LED (light-emitting diode) technology has advanced rapidly in recent years, and most modern recessed luminaires are now dedicated LED luminaires. Older recessed luminaires may be fitted with a variety of lamp types including:

- incandescent lamps
- compact fluorescent lamps (CFLs)
- low voltage halogen lamps up to 50 W
- mains voltage halogen lamps (generally as replacements for incandescent lamps).

5.0.2 Light-emitting diodes are semiconductors that emit light when a current flows through them, and a diffuser distributes the light from individual or clusters of diodes. LED lights are far more efficient at converting energy into light than incandescent, CFL and halogen lamps. As a consequence, recessed luminaires containing LED lamps do not produce a lot of heat, which means they are able to be covered by ceiling insulation. Another advantage is that manufacturers claim that the lamps have up to 50,000 hours of life.

5.0.3 Incandescent lamps create light by running electricity through a filament, which makes it heat up and glow. This makes them a fairly energy-inefficient form of light. They are available in a variety of forms including ordinary incandescent lamps and lamps with reflectors incorporated, such as the R80 reflector lamp. While reflector lamps are better suited to downlight applications than ordinary incandescent lamps, they are still less efficient when compared to other lamp types. Incandescent lamps have a low initial cost and produce a warm light but they have a relatively short life of around 1,000 hours.

5.0.4 Like fluorescent tubes, CFLs create light by passing electricity through a mercury-containing gas inside a lamp tube lined with a fluorescent coating.

Figure 4. Example of a warning sign required in an accessible roof space.

Figure 5. Example of the regulatory compliance mark.

They are available in either spiral or linear form and are fitted with a built-in starter and a ballast to control the current through the lamp. The colour they produce and the ability for people under this light to identify different colours (their colour-rendering index) differ significantly from incandescent lamps, and they have an average life of between 5,000 and 15,000 hours.

5.0.5 Halogen lights contain a halogen gas, and light is produced when electricity is run through a filament in the halogen gas. The presence of the gas allows the filament to run at a higher temperature than incandescent filaments, producing a higher light output. This also means they generate considerably more heat. Some lamps have dichroic reflectors to reflect light from the front of the lamp while the heat can escape through to the back of the lamp. They are generally 12 or 24 volt luminaires so they require a transformer. Their colour-rendering index is good, and they have a life of around 2,000 hours.

5.1 BEAM ANGLE

5.1.1 The spread of light from any type of lamp depends on beam angle – a wider beam gives a more even spread of light. A beam angle of 60° is recommended for general lighting, while a narrow beam can be used for highlighting a display piece.

6 REPLACING LAMPS

6.0.1 The energy efficiency and long life of LED lamps means they are rapidly replacing halogen, CFL and incandescent lamp technologies. In order to swap new lamps for old, there must be physical and electrical compatibility, but nevertheless, maximum electrical and optical efficiency may not be achieved by simply installing LED lamps.

6.0.2 Lighting systems consist of:
- the light source or lamp
- the fitting
- the design of the luminaire – the type of reflector and lighting optics.

6.0.3 The overall performance of the luminaire is based on all three components so the replacement of a halogen, CFL or incandescent lamp with an LED lamp will not necessarily produce the best performance – for example, some of the earlier light fittings had poor reflectors or optics. Replacement may result in poorer-quality and less-efficient lighting from the LED lamp than if it was installed in a compatible fitting.

6.0.4 There are a number of long-term benefits from replacement with LED lamps including:
- long-term cost savings provided by long-life LED lamps installed into compatible fittings
- a reduction in heat loss through the ceiling if IC-rated recessed luminaires are installed so that ceiling insulation can be continuous
- improved lighting quality and efficiency.

6.0.5 If lamps in recessed luminaires need to be replaced, depending on the type of recessed luminaire and the lamp, a better option may be to replace the whole fitting rather than the lamp only. BRANZ recommends that, where older recessed luminaires are installed, the luminaire should be replaced with an LED fitting for safety, long-term cost and energy-saving benefits.

6.1 REPLACING MR16 HALOGEN LAMPS WITH MR16 LED LAMPS

6.1.1 The 50 W or 35 W MR16 dichroic 12 volt halogen lamp has been a key component of lighting systems since the 1980s. Halogen lamp technology provides a high level of compatibility with the extensive range of luminaires, transformers and other control gear available.

6.1.2 The most common installed halogen lamp is a multi-faceted reflector MR16 halogen lamp. It has 2-pin base connection referred to as a GU5.3 or GX5.3 and is designed to operate at a low voltage (typically 12 volts) because of the optical advantage gained through the use of a small filament.

6.1.3 The MR16 LED is a retrofit lamp that has been designed to replace the MR16 halogen lamp using the existing transformer and dimmer (if installed). Note that there is also an MR16 that runs off 240 V and has a different base known as a GU10, and these should not be mixed up.

6.1.4 When replacing an MR16 halogen lamp with an MR16 LED lamp, ensure that the LED lamp:

- is a direct replacement for the halogen lamp
- has a compatible base connection (i.e. GU5.3 or GX5.3)
- is compatible with the existing transformer (i.e. magnetic or electronic)
- is compatible with the dimmer (if installed).

6.1.5 Other replacement requirements:

- Luminaires with multiple halogen lamps must have all lamps replaced with MR16 LED lamps.
- All halogen lamps connected to the same transformer must be replaced – do not mix MR16 halogen and LED lamps.
- Follow the dimmer manufacturer's recommendations when retrofitting LED lamps. In some cases, several LED lamps may be required per dimmer to provide sufficient load for the dimmer to operate properly.

6.2 SELECTING LED LAMPS

6.2.1 Lamps have previously been rated by the wattage of the lamp, but LEDs are measured in lumens rather than watts. A lumen is a measure of brightness or total light output emitted from the light source. A higher lumen value means a brighter light is produced.

6.2.2 A watt is the electrical unit for the rate at which energy is generated or consumed. Incandescent, CFL and halogen lamp brightness or light output is defined in watts but in fact describes the amount of energy being used – for example, a 100 watt lamp is using 100 joules of electricity for every second of use, with much of it converted to heat. Table 2 provides an approximate brightness comparison between lumens and watts for different types of lamps.

7 TRANSFORMERS

7.0.1 Transformers are used to convert the 240 volt mains supply AC current to 12 or 24 volt DC current. A separate transformer is generally required to drive each 12 or 24 volt luminaire. Transformers are either

Table 2. Approximate brightness comparison between lumens and watts.

Brightness in lumens	LED equivalent (watts)	CFL equivalent (watts)	Halogen equivalent (watts)	Incandescent equivalent (watts)
1,400	15	24	70	100
1,000	12	20	52	75
700	8	15	42	60
400	6	12	28	40
200	4	7	18	25

electronic or electromagnetic although electronic transformers are generally now more commonly used.

7.0.2 Transformers should be the type and in the location as recommended by the manufacturer. They are affected by heat, so unless otherwise recommended by the manufacturer, they should be installed above the insulation.

8 GLOSSARY

ballast	A device installed between the power supply and one or more lamps to regulate and limit the current of the lamps.
bulb	The outer glass casing of a lamp.
lamp	A device fitted into the luminaire for emitting light – includes the bulb and the light source.
lamp control gear	One or more elements designed that can be mounted separately from the luminaire without an additional protection or enclosure.
luminaire	A device that holds the lamp(s) and distributes the light transmitted from the lamp(s). It includes all the parts necessary for supporting, fixing and protecting the lamp(s) as well as the connections for the lamp(s) to the power supply.
recessed luminaire	A luminaire that is fully or partially recessed into the mounting surface, typically a ceiling.
reflector	A reflective surface to redirect light.
TIR optics/ TIR lens	TIR (total internal reflection) optics or lenses consist of a refractive lens inside a reflector that directs light from the source to the reflector from where it is emitted in a controlled beam.

9 STANDARDS

AS/NZS 1680.1:2006 *Interior and workplace lighting – Part 1: General principles and recommendations*

AS/NZS 3000:2007 *Electrical installations (known as the Australian/New Zealand Wiring Rules)*

AS/NZS 3000:2018 E*lectrical installations (known as the Australian/New Zealand Wiring Rules)*

AS/NZS 60598.1:2017 *Luminaires – Part 1: General requirements and test* (including Amendment A).

AS/NZS 60598.2.2:2001 *Luminaires – Part 2.2: Particular requirements – Recessed luminaires* (including the New Zealand-only Amendment A)

AS/NZS 60598.2.2:2016 *Luminaires – Part 2.2: Particular requirements – Recessed luminaires*

NZS 4246:2016 *Energy efficiency – Installing bulk thermal insulation in residential buildings*

NZS 6703:1984 *Code of practice for interior lighting design*

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