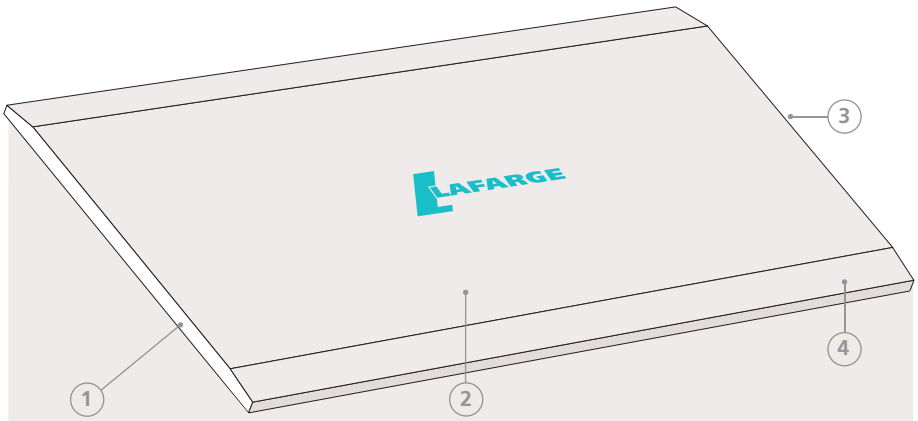
3 BUILDING WITH PLASTERBOARD

3.1 PLASTERBOARD PROPERTIES

3.2 CARE AND USE OF PLASTERBOARD

3.3 BUILDING REQUIREMENTS AND SOLUTIONS



Plasterboard is the most commonly used building material worldwide for internal wall and ceiling linings. It is made from a core (1) of a naturally occurring mineral called gypsum, also known as calcium sulphate dihydrate or $CaSO_4.2H_2O$. The core is sandwiched between two layers of heavy duty recycled paper (2). The face paper is suitable for painting or wallpaper. Plasterboard has square profile cut ends (3) and long recessed edges (4) to enable easy jointing.

Plasterboard systems provide a wide variety of economical construction solutions that are recognised for their light weight and high performance.

Lafarge manufactures plasterboard to high internal standards which meet or exceed the requirements of AS/NZS 2588, *Gypsum Plasterboard*.

Plasterboard must be installed and finished according to the requirements of AS/NZS 2589:2007, *Gypsum linings - Application and finishing*.

ENVIRONMENTAL BENEFITS

Plasterboard is an ideal product for sustainable construction. As a light weight building material, plasterboard reduces transport costs and emissions as well as the total weight of buildings. Plasterboard is also 100% recyclable, with low embodied energy, and made largely from a naturally occurring mineral - gypsum. Lafarge Plasterboard sources its gypsum from large natural reserves within Australia. The liner paper used to make plasterboard is biodegradable and made from recycled paper such as waste newspaper and cardboard.

The plasterboard manufacturing process operates under strict environmental guidelines:

- Efficient use of energy and water: including heat recovery and storm water collection
- Effective collection and monitoring of dust
- Ongoing waste and raw material usage reduction
- Minimisation of plant impact on surroundings.

For more information refer to our website: lafargeplasterboard.com.au/sustainability/Our-Commitments

DIMENSIONAL STABILITY

Plasterboard is dimensionally stable when compared to other building materials.
Two measures of dimensional stability are listed below:

- Thermal coefficient of linear expansion (α) = 16.7 x 10^{-6} / °C, measured unrestrained over the temperature range of 3°C – 32°C
- Hygrometric coefficient of expansion = 6.5 x 10^{-6} / %RH, measured unrestrained over the Relative Humidity (RH) range of 10% - 90%.

FIRE RESISTANCE

All Plasterboard is naturally fire resistant and is classified as non-combustible according to the Building Code of Australia (BCA) Section C1.12. The core slows down the spread of fire by releasing chemically bound water when heated. This is a similar process to evaporation and aids cooling.

FIRE HAZARD PROPERTIES

Fire Hazard Indices have been superseded in the BCA Section C1.10 by 'Fire Hazard Properties'. Wall and ceiling materials are required to be tested and classified with a Group number from 1 to 4, with Group 1 being the least fire hazardous. Fire hazard properties relate to the combustibility of plasterboard, not its performance in a fire test.

The following products are classified as Group 1:

MastaShield, **SpanShield**, **FireShield**, **ImpactShield**, **QuadShield**, **WaterShield**, **MultiShield**, **SafeShield**, **SoundShield**, **AcoustiShield**, **CurveShield**, **MastaDeco**, **ShaftLiner**, **GIB X-Block**, **SpanGrid** Ceiling Panel - Paper Faced.

The following product is classified as Group 2: **SpanGrid** Ceiling Panel - Vinyl Faced.

All Lafarge Plasterboard products have an Average Specific Extinction Area of <250 m^2/kg as required by Specification C1.10a, Clause 3(c) of the BCA.

THERMAL PROPERTIES

THERMAL 'R' VALUE

The R-value of plasterboard is a measure of its thermal insulation ability. Higher numbers indicate a better insulator. The values for plasterboard are:

- 10mm plasterboard = 0.059 Km^2/W
- 13mm plasterboard = 0.081 Km^2/W
- 16mm plasterboard = 0.101 Km^2/W

SPECIFIC HEAT CAPACITY

The specific heat capacity of plasterboard is the amount of heat energy required to raise the temperature of 1kg of plasterboard by 1°C. The value for plasterboard is 1090 J/kgK.

SAFETY

Standard plasterboard is not classified as hazardous according to the criteria of National Occupational Health and Safety Commission (NOHSC). It is non-toxic and non-flammable.

- Material Safety Data Sheets (MSDS) are available at lafargeplasterboard.com.au or by calling 1300 724 505.
- Some plastering compounds have safe handling requirements. [REFER TO THE HEALTH AND SAFETY INFORMATION PRINTED ON THE COMPOUND PACKAGING FOR DETAILS].

STORAGE, DELIVERY AND HANDLING

Plasterboard must be kept dry and should be stacked clear of the floor using supports not more than 600mm apart as shown in Figure 1. If outdoor storage is unavoidable, plasterboard and accessories should be fully protected from the weather. Plasterboard that has been exposed to direct sunlight, or has been fixed and left standing unpainted for long periods, may become discoloured. If this happens, it must be sealed with a stain sealer undercoat as recommended by the paint manufacturer.

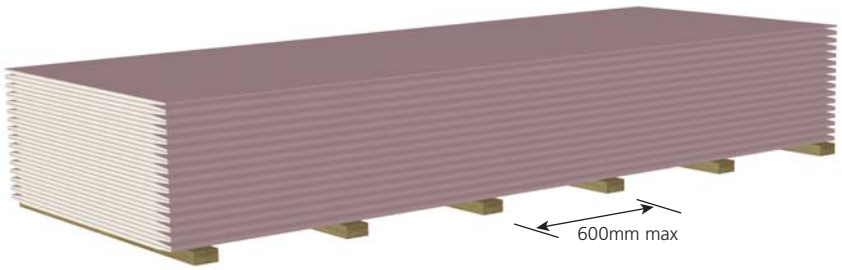
Reduce the possibility of damage to plasterboard, arrange delivery to site immediately before installation. During delivery, care should be taken not to damage recessed edges.

Exposure to excessive humidity during storage can result in plasterboard becoming damp and soft, and may appear defective. In this case allow the plasterboard to dry out and handle with care during installation.

To help protect plasterboard from absorbing humidity:

- Avoid open sources of water such as wet floors
- Wrap the plasterboard with plastic overnight
- Provide ventilation
- Install soon after delivery
- Install during dry weather for best results.

FIGURE 1
Storage of plasterboard



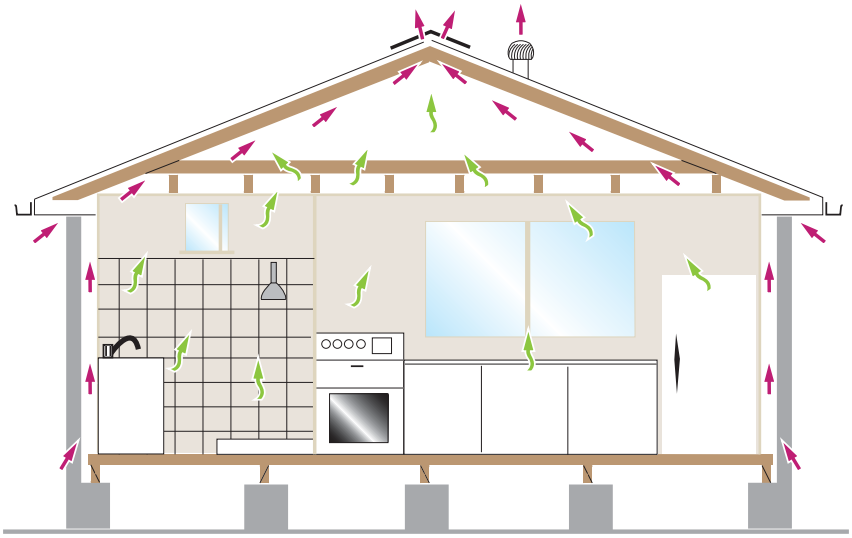
CONDENSATION AND VENTILATION

Plasterboard must not be installed until the building is weatherproof, particularly in coastal areas subject to sea spray. Complete all exterior doors, walls, windows and the roof before installing plasterboard. Prevent rain from entering buildings, avoid water on floors or other sources of open water and allow wet concrete or masonry to dry. These precautions will reduce excessive humidity that may be absorbed by timber or unpainted plasterboard and minimise defects caused by timber shrinkage or moist plasterboard.

Condensation of water onto either the face or back of the plasterboard must be avoided. Insufficient protection from condensation can result in joint distortion, plasterboard sagging, mould growth and fastener popping.

Many inter-related factors must be taken into account to control condensation. Good practice is to make use of wall and ceiling insulation, vapour barriers, and especially ventilation. Ventilation must be considered for the spaces in walls, under floors and in particular under roofs.

FIGURE 2
Condensation and ventilation



To minimise the effects of condensation:

- Use **WaterShield**, **SafeShield**, **MultiShield** or **QuadShield** to increase protection against moisture.
- Use moisture barriers, sarking, and insulation. However, it is important that the right type is selected for the construction type and that it is installed correctly [REFER TO THE MANUFACTURER'S SPECIFICATIONS].
- Use foil backed insulation under metal roofs as they are susceptible to forming condensation.
- Install eave vents, gable vents and roof ventilators in the roof cavity [AS SHOWN IN FIGURE 2].
- Remove humidity from bathrooms via an exhaust fan to the outside.
- In hot and humid climates where the building is air-conditioned below the dew point of the outside air, the wall and ceiling framing members and internal linings should be fully protected by moisture barriers to separate them from the humid external air. The moisture barriers should be thermally insulated to maintain them at a temperature above the dew point.
- Use a quality paint system to provide protection against paint peeling and condensation soaking into plasterboard and compounds.

EXTERNAL CEILINGS

External ceilings are subjected to harsher conditions than internal ceilings, therefore they must be protected from the weather as specified in this section. This extra protection is designed to control the major causes of external ceiling faults which are:

- Water condensing on the plasterboard,
- Water condensing on framing or roof lining and dripping down onto the plasterboard,
- Water penetrating the paint system.

MINIMUM CONDITIONS TO USE PLASTERBOARD IN CEILINGS FOR ALFRESCO AREAS, CARPORTS, BALCONIES AND BREEZEWAYS
The plasterboard and compounds will not be subjected to any direct water, long periods of high humidity, sea spray or damp conditions.
Minimum 100mm clearance from external ceiling lining to lower edge of verandah beam or masonry lintel, otherwise provide protection against wind blown rain. [REFER TO FIGURES 5, 6, 7 8 AND 9]
The plasterboard framing must be designed for the appropriate wind loading conditions.
The cavity above the plasterboard ceiling must have cross ventilation [REFER TO CONDENSATION AND VENTILATION].
Sarking and thermal insulation must be used to improve temperature control, reduce wind pressure and control condensation.
INSTALLATION REQUIREMENTS FOR EXTERNAL CEILINGS
Use either 10mm **SpanShield**, 13mm **MastaShield**, 10mm **SoundShield**, 13mm **SoundShield**, 13mm **FireShield**, 16mm **FireShield** or 13mm **ImpactShield**.
For improved water resistance, use either 13mm **WaterShield**, 13mm **MultiShield** or 13mm **QuadShield**.
Ceiling framing at maximum 450mm framing centres.
Use thermal insulation directly above the plasterboard. This will minimise the temperature difference between the plasterboard and outside air, limiting ceiling sag and mould formation by reducing condensation on the plasterboard.
Fix the ceiling sheets using the 'Screw Only Method'. Nails are not permitted in the installation. [REFER TO SECTION 4.4.1 FOR CEILING INSTALLATION] Additional screws may be required for high wind areas.
Provide additional framing around the perimeter by inserting trimmers between ceiling frames or installing steel angle. [REFER TO FIGURES 3 AND 4]
Fix the perimeter of the plasterboard sheets using screws at 300mm maximum spacing.
Install control joints in at 6m maximum intervals.
Back-block all plasterboard joints. [REFER TO SECTION 5.2]
Set joints using two coats of **MastaBase** or **MastaLongset** and a Lafarge finish coat.
Roll or brush on a high quality sealer undercoat designed for exterior use.
Use a premium exterior paint system that includes a mould inhibitor.

Please note that plasterboard must not be installed in eaves, or as exterior cladding.

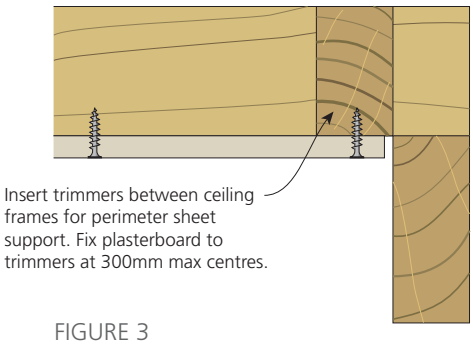


FIGURE 3
Perimeter Trimmers
External Ceilings

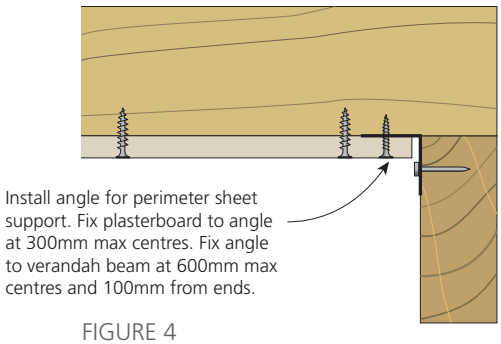


FIGURE 4
Perimeter Angle
External Ceilings

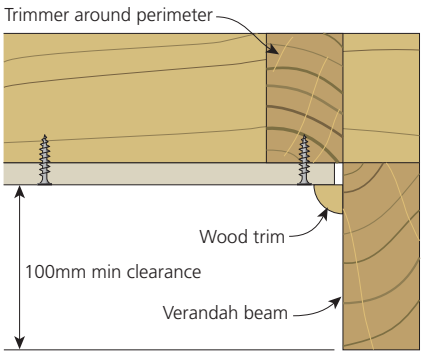


FIGURE 5
External Ceilings
With wood trim

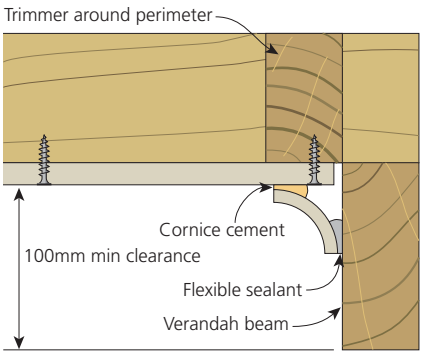


FIGURE 6
External Ceilings
With cornice

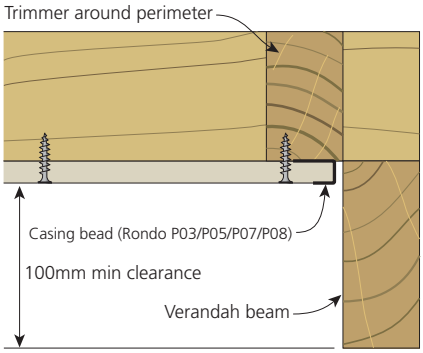


FIGURE 7
External Ceilings
With casing bead

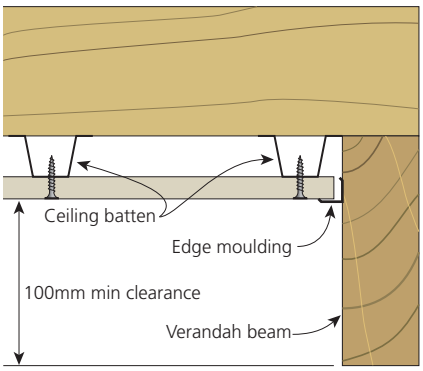


FIGURE 8
External Ceilings
With edge moulding on battens

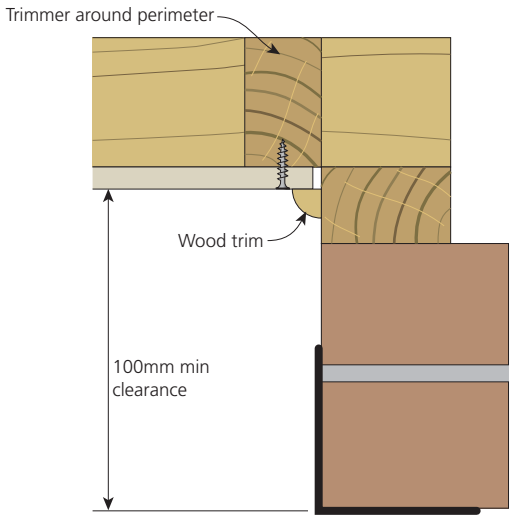


FIGURE 9
External Ceilings
With wood trim to masonry lintel

GARAGE CEILINGS

Garage ceilings are subject to conditions that are more demanding than in other parts of the home. This is the case even when garages are located under the same roof as the rest of the home. Garages have large doors that when open let in rain and strong wind, cars are garaged wet, and they are not normally heated spaces. These factors call for a more durable installation to avoid future maintenance issues.

MINIMUM CONDITIONS TO USE PLASTERBOARD IN GARAGE CEILINGS
The plasterboard framing must be designed for the appropriate wind loading conditions.
The cavity above the plasterboard ceiling must have cross ventilation. [REFER TO CONDENSATION AND VENTILATION]
INSTALLATION REQUIREMENTS FOR GARAGE CEILINGS
Fix the ceiling sheets using the 'Screw Only Method' or the 'One Third Fixing Method' [REFER TO SECTION 4.4.1 FOR CEILING INSTALLATION]
Provide additional framing around perimeter by inserting trimmers between ceiling frames or installing steel angle. [REFER TO FIGURES 10 AND 11]
Fix the perimeter of the sheets using screws at 300mm maximum spacing.
Avoid windy conditions during and immediately after installation to ensure adhesive sets intact.
Back-block all plasterboard joints. [REFER TO SECTION 5.2]
Roll or brush on a high quality sealer undercoat designed for exterior use.
Use a premium exterior paint system that includes a mould inhibitor.

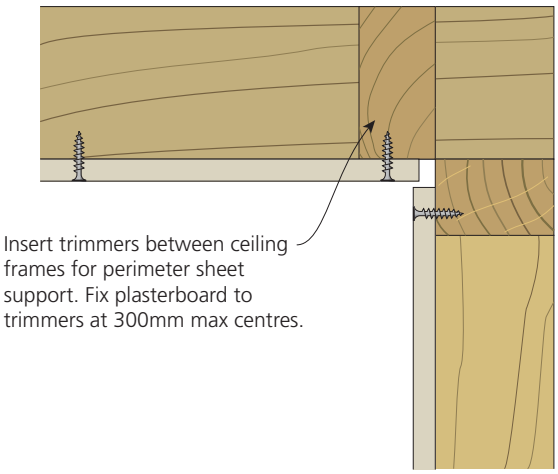


FIGURE 10
Perimeter Trimmers
Garage Ceilings

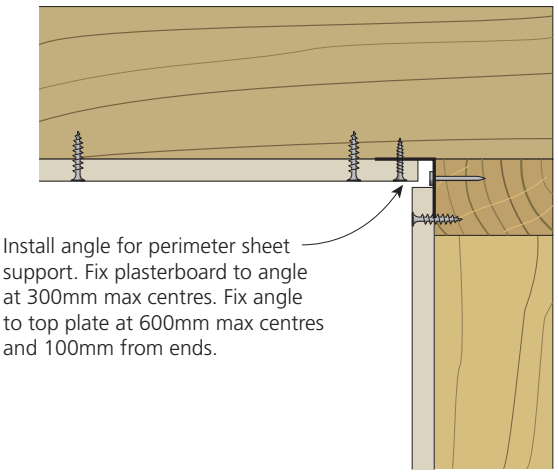


FIGURE 11
Perimeter Angle
Garage Ceilings

EXPOSURE TO HIGH HUMIDITY

Ceilings in rooms such as indoor swimming pools and communal showers are subject to long periods of high relative humidity (above 90%). The use of plasterboard on these ceilings is not guaranteed by Lafarge Plasterboard.

WaterShield, **MultiShield** or **QuadShield** completely covered with a waterproof membrane complying with AS/NZS 4858:2004 may be used for walls in rooms subject to long periods of high relative humidity. Vertical junctions and wall to floor junctions must also be waterproof [REFER TO SECTION 4.1.4 FOR INSTALLATION OF WET AREAS].

For rooms with intermittent periods of high relative humidity such as bathrooms, **WaterShield**, **MultiShield** or **QuadShield** may be used. In these rooms a source of ventilation is required to enable removal of excess moisture, such as an open window or exhaust fan.

EXPOSURE TO EXCESSIVE HEAT

Plasterboard is an ideal building material for normal ambient temperatures. It is not suitable for long periods at elevated temperatures such as installed near fireplace flues or chimneys. **FireShield** is no exception. It is designed to slow down a fire, not to resist constant elevated temperatures.

The effect of high temperatures on plasterboard is to chemically dehydrate the core. This process generally begins at around 80°C but can occur at lower temperatures under certain conditions. AS/NZS 2589:2007, *Gypsum linings – Application and finishing*, states that plasterboard must not be exposed to temperatures above 52°C for prolonged periods.

Heat generating appliances have installation instructions for the correct distances between plasterboard linings and heat sources. The Building Code of Australia (BCA) also has requirements for installation of heating appliances.

GLASS OR STAINLESS STEEL SPLASHBACK

For compliance with AS 5601-2004 *Gas Installations*.

CLEARANCE TO GLASS OR STAINLESS STEEL SPLASHBACK IS LESS THAN 200mm *
No plasterboard product may be used behind a glass or stainless steel splashback without tiles. Any plasterboard may be used if it is behind ceramic tiles of minimum 5mm thickness, although in this case **SafeShield** is recommended for additional fire and water resistance.
CLEARANCE TO GLASS OR STAINLESS STEEL SPLASHBACK IS 200mm OR MORE
Any plasterboard product may be used, although **SafeShield** is recommended for additional fire and water resistance. The wall surface must still be covered with a glass or stainless steel splashback.

* The minimum clearance from the gas burner to the splashback must be 140mm.

USING PRODUCTS IN SYSTEMS TO MEET BUILDING REQUIREMENTS

Lafarge Plasterboard offers systems for a large variety of building requirements:

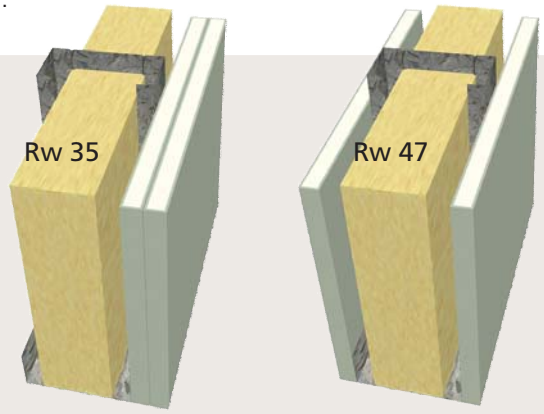
- Fire protection
- Sound insulation
- Noise absorption
- Wet areas
- Impact resistance
- X-Ray shielding
- Aesthetics.

These systems are composed of plasterboard and jointing compounds, along with framing and other specified materials such as adhesives, sealants, screws and insulation. While the products alone do not provide performance, using them in the complete assembled system will. Always check that the building solution you have selected complies with the requirements of the Building Code of Australia.

FIGURE 12

Two systems with different configurations but using the same products

Both systems in Figure 12 use exactly the same products, but have a significant difference in acoustic performance. The system on the left has Rw of 35, while the system on the right has Rw of 47. There is a large difference in the performance between these two wall systems as a result of the type of construction.



System performance relies on following the correct installation details such as stud spacing and fixing centres, as well as using the nominated components such as plasterboard, compounds, studs and insulation. Even small details like sealing gaps can have a large effect on system performance. Variations in construction or materials may reduce a system's fire and acoustic rating, structural capacity or other aspects of performance.

Steel components

Unless otherwise stated, systems in this manual were designed using steel components manufactured by Rondo Building Services Pty. Ltd. Alternative components may only be used:

- In accordance with the respective manufacturer's literature, or
- If their performance is equivalent or better and they comply with the relevant standard.

Timber components

Unless otherwise stated, systems in this manual were designed using grade MGP10 timber.

Timber is a natural product and its dimensions vary with changes in surrounding moisture. Timber should be allowed to reach equilibrium with its surroundings before lining it with plasterboard. The equilibrium moisture content of timber is usually 10-14%.

Fasteners

Green timber and certain treated timbers such as Copper Chromium Arsenate (CCA) are corrosive to steel components, especially in combination with moisture. Select appropriate fasteners for the conditions by consulting the manufacturer.

CORROSION CLASS OF FASTENER	APPLICATION
1	General internal use
2	High humidity internal use
3	External environments
4	Marine environments

Insulation

Unless otherwise stated, systems in this manual were designed using Insulco® glasswool and polyester products manufactured by Fletcher Insulation. Alternative products may only be used:

- In accordance with the respective manufacturer's literature, or
- If their performance is equivalent or better and they comply with the relevant standard.

Insulation used should not be thicker than recommended for the cavity size. For example, when using insulation in a 51mm stud wall, use 50mm insulation, not 65mm. Tightly compressing insulation into the cavity may reduce acoustic performance.

Minimum densities for insulation nominated in Lafarge Plasterboard systems are listed in the following table.

INSULATION DESCRIPTION	MINIMUM DENSITY (kg/m³)
50mm Glasswool	11
50mm Glasswool Semi-Rigid	32
75mm Glasswool	11
65mm Glasswool Acousti-Therm	16
75mm Glasswool Acousti-Therm	16
95mm Glasswool Acousti-Therm	20
50mm Polyester Sound Blanket No.2	7
65mm Polyester Sound Blanket No.3	7
75mm Polyester Sound Blanket No.4	8
100mm Polyester Sound Blanket No.6	10
75mm Polyester Polycoustic	16
95mm Polyester Polycoustic	16

Insulations with a nominated R value have no restrictions on density or thickness.

Fibre cement

Systems in this manual that include fibre cement were tested and evaluated using James Hardie fibre cement products.

STRUCTURE

FRAME DESIGN

AS 1170.0 *Structural Design Actions – General Principles* defines the loads that a structure is subjected to.

Wall and ceiling system framing must be designed according to the relevant standard:

- AS 1684 *Residential Timber Framed Construction*
- AS 1720 *Timber Structures*
- AS 4100 *Steel Structures*
- AS/NZS 4600 *Cold Formed Steel Structures*
- NASH *Standard for Residential and Low-rise Steel Framing, Part 1*
- AS 3623 *Domestic Metal Framing*
- AS/NZS 2785 *Suspended Ceilings.*

The MRTFC (Multi-Residential Timber Framed Construction) Design and Construction Manuals are a good source for timber framed construction including fire rated construction details.

Internal walls and ceilings

All internal wall systems and wall height tables published in this manual comply with the relevant section of BCA Specification C1.8. Wall heights for fire rated systems have been verified by independent fire engineers.

As a minimum, all internal wall systems published in this manual comply with the deflection under the Uniformly Distributed Load (UDL) requirements from BCA Specification C1.8. The allowable deflection under a static pressure of 0.25 kPa must be less than either the wall height ÷ 240 or 30mm.

Some applications have additional requirements such as the walls of shafts and fire isolated exits. Unusually strong wind loading conditions such as those experienced in tall buildings may require internal walls and ceilings to be designed to higher pressures than the standard 0.25 kPa [REFER TO BCA].

Frame fasteners

Ensure fasteners used to fix top and bottom track/plate are appropriate for the Uniform Distributed Load (UDL) on walls. At 600mm fastener centres and UDL of:

- 0.25 kPa, the fasteners must withstand a shear load of 0.75 kN.
- 0.35 kPa, the fasteners must withstand a shear load of 1.1 kN.

External walls and ceilings

Frame design of external wall systems must consider local environmental loading conditions and applied vertical load on the studs. [REFER TO AS 1170.0 *Structural Design Actions – General Principles*].

Control joints

Control joints allow for any building movement resulting from influences such as moisture migration, loading, structural movement and foundation settlement. Cracks in plasterboard and plasterboard joints should be eliminated by using control joints and the correct installation techniques.

Control joints must be installed in plasterboard walls and ceilings at:

- Maximum 12 metre intervals
- Control joints in the structure
- Any change in the substrate material.

Distance between control joints may need to be reduced to less than 12 metres due to conditions such as large temperature or humidity variations.

FIRE RESISTANCE

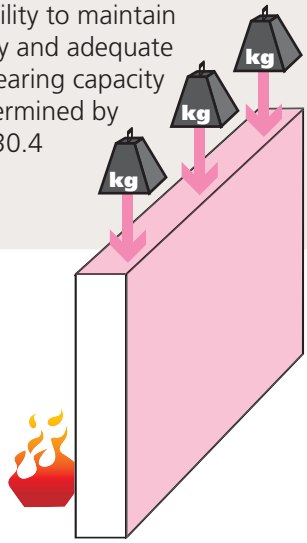
FIRE TERMS AND DEFINITIONS

Fire Resistance Level

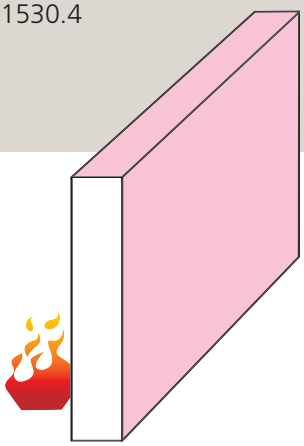
Fire systems are rated to withstand a fire under test conditions for a certain period of time. This time is known as the Fire Resistance Level (FRL) and consists of the three criteria listed below:

60 / 60 / 60

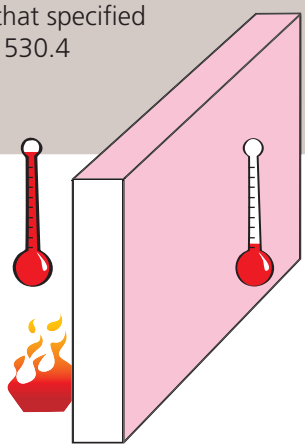
STRUCTURAL ADEQUACY
The ability to maintain stability and adequate load bearing capacity as determined by AS 1530.4



INTEGRITY
The ability to resist the passage of flames and hot gases as specified by AS 1530.4



INSULATION
The ability to maintain a temperature over the whole of the unexposed surface below that specified by AS 1530.4



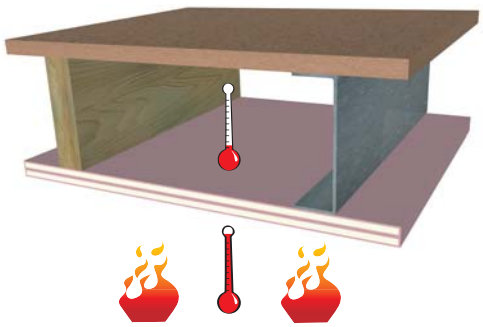
The example above shows FRL of 60/60/60. This means that during a fire test, the system did not fail for 60 minutes for each of the criteria.

A dash in FRL means no requirement for that criterion. For example, 90/–/– means there is no requirement for Integrity and Insulation. Structures such as non-load bearing walls do not have FRL requirement for Structural Adequacy, for example –/60/60.

Fire testing is carried out in accordance with AS 1530.4 *Methods for fire tests on building materials, components and structures*. All fire rated plasterboard systems in this manual have been independently tested or assessed by qualified fire engineers.

Resistance to incipient spread of fire (RISF)

Resistance to the Incipient Spread of Fire (RISF) is the ability of a ceiling to limit the temperature rise in the ceiling cavity [SHOWN BELOW]. The RISF is a requirement of the BCA in specific applications. It is aimed at preventing 'flashover', which is when a fire starts spontaneously due to high temperatures. The RISF for Lafarge fire rated ceilings are stated in the system tables.



Acceptable variations to fire rated systems

Fire rated systems must be built according to the installation instructions in Section 4. However, there are some variations allowed that will not degrade the performance of the system:

- Increasing cavity width
- Increasing stud size or metal thickness
- Adding noggings to support fixtures or services
- Decreasing stud spacing
- Decreasing fastener spacing
- Substituting 13mm **FireShield** with 13mm **MultiShield** or 13mm **ImpactShield** or 13mm **QuadShield**.
- Substituting 16mm **FireShield** with 16mm **MultiShield**.
- Adding additional linings to a system up to a weight of 20 kg/m^2 and no thicker than 25mm. This includes fibre cement board up to 9mm thick and plasterboard up to 25mm thick. For load bearing walls, the load per stud must include the extra lining.

Modifications to fire rated systems

Fire rated systems are often modified by the installation of:

- Fire rated inspection hatches
- Fire rated power points
- Fire rated light fittings
- Fire rated doors
- Fire dampers
- Electrical cables
- Metal or plastic pipes
- Other fire rated penetrations.

It is the responsibility of the manufacturer of these components to ensure that the fire and acoustic properties of the plasterboard system are maintained.

[SOME MODIFICATIONS ARE DETAILED IN SECTION 4]. Any modification not covered in this manual must be according to the relevant manufacturer's instructions.

SMOKE WALLS

The purpose of a smoke wall is to prevent smoke passing from one side of a wall to the other. The perimeter and all penetrations must be sealed with fire sealant. A smoke wall must be built from non-combustible materials such as plasterboard, compounds, glasswool insulation and fire sealant.

Doors and windows used in smoke walls must comply with requirements in the BCA *Specification C2.5*. Ducts through the smoke wall must use a smoke damper, unless the duct is part of the smoke handling system and is required to function during a fire.

Class 9a health-care buildings

Smoke walls in Class 9a buildings must extend up to:

- A non-combustible roof or
- A ceiling having a RISF of 60 minutes.

Class 9c aged care buildings

Plasterboard used for smoke walls in Class 9c buildings must have a thickness of at least 13mm. Smoke walls in Class 9c buildings must extend up to:

- A non-combustible roof or
- A jointed plasterboard ceiling with a minimum thickness of 13mm.

FireShield, MultiShield and ImpactShield to Resist Fire

Lafarge Plasterboard recommends the installation of **FireShield**, **MultiShield**, **ImpactShield** or **QuadShield** wall and ceiling systems to control the spread of fire. These specially formulated products contain additives that improve the natural fire resisting properties of plasterboard.

SOUND INSULATION PERFORMANCE

There are two types of acoustic functions: sound insulation and noise absorption. This section explains common sound insulation terms. [NOISE ABSORPTION IS ADDRESSED LATER IN THIS SECTION.]

ACOUSTIC TERMS AND DEFINITIONS

Rw
Weighted Sound Reduction Index

Rw describes the airborne sound insulating power of a building element. It is a laboratory measured value. It can apply to walls, ceiling/floors, ceiling/roofs, doors, or windows. The higher the number, the greater the sound insulating power of the building element.

For example, an increase in the Rw of a wall by 10 points will reduce the perceived loudness of sound passing through the wall by about half. Table 1 shows how the sound insulating effectiveness of walls depends on their Rw or Rw + Ctr values.

TABLE 1
Effect of various walls on sound insulation performance

Rw	Rw + Ctr	EFFECT OF DIFFERENT VALUES OF Rw AND Rw + Ctr ON SOUND INSULATION PERFORMANCE
25	22	Normal speech can be heard easily
30	25	Loud speech can be heard easily
35	28	Loud speech can be heard but not understood
42	35	Loud speech heard as murmur
45	38	Must strain to hear loud speech
48	40	Loud speech can be barely heard
53	44	Loud speech can not be heard
63	55	Music heard faintly, bass notes 'thump'
70	60	Loud music still heard very faintly

Rw + Ctr
Rw plus Spectrum Adaptation Term

Rw + Ctr is equal to Rw with the addition of a low frequency sound correction, Ctr. The use of Rw + Ctr has been adopted due to the increase in low frequency sound sources such as surround sound systems, traffic and aircraft noise, drums and bass guitars.

Two walls can have the same Rw rating but have different resistance to low frequency sound, thus a different Rw + Ctr.

DnTw and DnTw + Ctr
Measured on-site

These values are the equivalent of Rw and Rw + Ctr, but measured on-site. Rw is the value measured in an acoustic laboratory, while DnTw is measured on-site.

An on-site measured value of DnTw + Ctr is permitted to be 5 points lower than the Rw + Ctr value. Where the BCA may call for an Rw + Ctr $\geq$ 50, the same requirement may be satisfied by measuring DnTw + Ctr $\geq$ 45 on-site.

Ln,w + Ci
Impact Sound insulation rating

Ln,w + Ci describes how easily impact sound travels through a wall or floor. Impact sound is generated by sources such as dryers, washing machines and heeled shoes on a wooden floor.

Unlike Rw values, better performing walls or floors have lower values. Therefore when specified, Ln,w + Ci values are maximums while Rw values are minimums. For example, the BCA requires some floors to have Ln,w + Ci $\leq$ 62.

Impact Sound insulation

Walls that have Impact Sound Insulation are defined in the BCA as walls that do not have any rigid mechanical connection between two separate leaves except at the perimeter.

Systems in this manual that satisfy this BCA requirement are staggered stud plasterboard walls with no noggins, and walls that use resilient mounts.

Impact Sound insulation with discontinuous construction

Discontinuous Construction is defined in the BCA as walls that have a gap of at least 20mm between two separate leaves. Double stud plasterboard walls connected only at the perimeter are classed as 'discontinuous' [REFER TO THE BCA FOR A COMPLETE DEFINITION.]

ACOUSTIC REQUIREMENTS

TABLE 2

BCA Acoustic Requirements for Sole Occupancy Units (SOU)

	AIRBORNE SOUND INSULATION	IMPACT SOUND INSULATION
BUILDING CLASS 1 - NSW, VIC, QLD, TAS, WA, SA and ACT		
Walls separating a bathroom, toilet, laundry or kitchen and a habitable room (other than a kitchen) in adjoining SOUs.	Rw + Ctr ≥ 50	✓ Discontinuous
Walls separating SOUs in all other cases.	Rw + Ctr ≥ 50	
Walls or ceilings separating a duct, soil, waste or water supply pipe or storm water pipe from a habitable room.	Rw + Ctr ≥ 40	
Walls or ceilings separating a duct, soil, waste or water supply pipe or storm water pipe from a kitchen, bathroom or other non-habitable room.	Rw + Ctr ≥ 25	
BUILDING CLASS 2 AND 3 - NSW, VIC, QLD, TAS, WA, SA and ACT		
Walls separating habitable rooms in adjoining SOUs.	Rw + Ctr ≥ 50	
Walls separating kitchens, toilets, bathrooms and laundries in adjoining SOUs.	Rw + Ctr ≥ 50	
Walls between a bathroom, toilet, laundry or kitchen and a habitable room (other than a kitchen) in adjoining SOUs.	Rw + Ctr ≥ 50	✓ Discontinuous
Walls between a SOU and a public corridor, public lobby, stairway or the like or parts of a different classification.	Rw ≥ 50	
Walls between a SOU and a plant room or lift shaft.	Rw ≥ 50	✓ Discontinuous
Walls or ceilings separating a duct, soil, waste or water supply pipe or storm water pipe from a habitable room.	Rw + Ctr ≥ 40	
Walls or ceilings separating a duct, soil, waste or water supply pipe or storm water pipe from a kitchen or other non-habitable room.	Rw + Ctr ≥ 25	
Floors between SOUs and between a SOU and a plant room, lift shaft, stairway, public corridor, public lobby or the like, or parts of a different classification.	Rw + Ctr ≥ 50	Lnw + Ci ≤ 62
BUILDING CLASS 1, 2 AND 3 - NORTHERN TERRITORY		
Walls separating a bathroom, toilet, laundry or kitchen and a habitable room (other than a kitchen) in adjoining SOUs.	Rw ≥ 50	✓
Walls separating SOUs in all other cases.	Rw ≥ 45	
Walls or ceilings separating a soil or waste pipe from a habitable room.	Rw ≥ 45	
Walls or ceilings separating a soil or waste pipe from a kitchen, bathroom or other non-habitable room.	Rw ≥ 30	
Floors between SOUs.	Rw ≥ 45	
BUILDING CLASS 9C - ALL AUSTRALIAN STATES AND TERRITORIES		
Walls separating SOUs from a kitchen or laundry.	Rw ≥ 45	✓ Discontinuous
Walls and floors separating SOUs and walls separating SOUs from a bathroom, toilet, plant room or utilities room.	Rw ≥ 45	

Table 2 lists some of the more common requirements but is not intended as a substitute for the BCA, and does not include Building Classes other than 1, 2, 3 and 9c [REFER TO THE BCA FOR THE FULL DETAILS OF ACOUSTIC REQUIREMENTS].

Performance requirements of the BCA relating to sound transmission and insulation can be satisfied by one of the following three options:

1. Deemed-to-Satisfy construction

Construct a wall or ceiling system that complies with the deemed-to-satisfy provisions of the BCA *Specification F5.2 – 2*. This section of the BCA details generic systems that satisfy the acoustic BCA requirements. However in general, more efficient solutions can be found in this manual.

2. Laboratory test or acoustic engineering

Construct a wall or ceiling system with an acoustic rating from this manual. The systems in this manual were either laboratory tested according to the relevant acoustic testing standard or were given an Acoustic Opinion made by Day Design Pty Ltd consulting acoustical engineers of Sydney NSW, or Marshall Day acoustic software.

Acoustic testing laboratories are designed to ensure that flanking paths do not occur. Tested partition systems are constructed with extreme care to achieve optimum performance. For these reasons, on-site performance may be different to laboratory performance.

3. On-site testing

Conduct on-site acoustic testing on a wall or ceiling system. This is a 'verification method' accepted by the BCA to confirm the performance requirements are met. Also the effectiveness of the complete installed system can be verified by on-site acoustic testing.

HIGHER ACOUSTIC REQUIREMENTS

Where performance is critical or noise is higher than normal, accredited acoustic engineers should be consulted. Their role is to ensure that design and construction will meet any specific requirements.

Acoustic predictions for systems not published in Lafarge Plasterboard's literature can often be generated by acoustic modelling software. Contact Technical Services for an acoustic prediction based on the Lafarge product range.

The Association of Australian Acoustical Consultants (AAAC) offer detailed guidance on acceptable acoustic performance. They have published their own star rating system. Ratings range from 2 to 6 stars and are based on field testing by an AAAC consultant to verify that they have been achieved. More information about AAAC Star Ratings for apartments and townhouses is available at www.aaac.org.au

ACOUSTIC TESTING AND ACTUAL PERFORMANCE

Attention to detail during construction is important for achieving good acoustics, as performance is governed by the weakest link in the system. Performance of installed acoustic systems may fall short of laboratory measured results. Acoustic measurements in a typical laboratory test represent the maximum performance that can be achieved. Meticulous care goes into laboratory installation of the system.

Actual site conditions are usually less than ideal and sound flanking paths normally exist around the perimeter of the system. Flanking paths may be minimised by sealing the perimeter with acoustic sealant, including behind the cornice and by installing services using acoustically rated details.

DESIGNING FOR ACOUSTIC PERFORMANCE

Acoustic performance is easier and cheaper to achieve if it is considered before construction begins. Good acoustic design includes:

- Selection of appropriate systems to limit sound transmission and/or sound reverberation
- Thoughtful design of the building layout
- Consideration of flanking paths.

Flanking paths are ways sound can travel around barriers, such as through windows, ceiling cavities, under doors and along services.

The sound insulating capability of a basic wall or ceiling system can be upgraded by using a combination of:

- Lafarge **SoundShield**
- Multiple plasterboard layers
- Insulation
- Resilient mounts
- Resilient channel
- Larger size studs
- Double stud walls
- Staggered stud walls
- Rondo Quiet Stud
- Sealant in all gaps.

SoundShield for Superior Noise Control

Lafarge Plasterboard recommends the installation of **SoundShield** wall and ceiling systems to minimise noise from aircraft, traffic and neighbours.

SoundShield is a plasterboard with enhanced acoustic qualities. **SoundShield** has a super high-density* core helps to resist the transmission of noise into rooms.

*The denser the plasterboard, the better it will resist sound transfer.

WET AREAS

The BCA requires wet area construction to protect the occupants from dangerous or unhealthy conditions, and to protect the building from damage. Acceptable construction for wet areas is detailed in the BCA and Australian Standard AS 3740, *Waterproofing of Wet Areas within Residential Buildings*. The installation instructions in Section 4.1.4 of this manual comply with AS 3740-2004.

WaterShield, **SafeShield**, **MultiShield** and **QuadShield** are water resistant plasterboards. They are suitable for use as 'water resistant substrates' in the waterproofing of wet areas according to AS 3740. **MultiShield** and **QuadShield** are water resistant plasterboards that are also fire resistant and can be substituted for **FireShield** in all systems. **SafeShield** can be substituted for 10mm **WaterShield** wherever desired.

WaterShield, **SafeShield**, **MultiShield** and **QuadShield** are manufactured to high internal standards that meet or exceed the requirements water resistant gypsum board within Australian Standard AS 2588, *Gypsum Plasterboard*.

Water Resistant Plasterboard for Wet Areas

Lafarge Plasterboard recommends the installation of **WaterShield** or **SafeShield** to resist moisture in wet areas like showers, bathrooms and laundries. For areas that require a fire rating as well as water resistance Lafarge Plasterboard recommends a **MultiShield** and **QuadShield** system.

WaterShield, **SafeShield**, **MultiShield** and **QuadShield** are ideal substrates for tiles as they are dimensionally stable.

WaterShield, **SafeShield**, **MultiShield** and **QuadShield** are water resistant, however they are not waterproof. Direct contact with water over time must be avoided and if plasterboard has been water damaged, replace it.

Precautions against condensation listed in Section 3.2 'Condensation and Ventilation' must be followed. For external use of plasterboard [REFER TO SECTION 3.2 EXTERNAL CEILINGS].

SPECIFIC REQUIREMENTS

SOUND ABSORPTION

Hard surfaces reflect sound and can create noisy rooms or halls. Noise absorbing systems with NRC rating control noise by reducing sound reflections.

The Noise Reduction Coefficient (NRC) is the term used to rate a system for its ability to absorb sound. The larger the NRC value, the better the sound absorption of the system.

Noise Reduction Guidelines

NOISE REDUCTION COEFFICIENT	ROOM OR AREA
0.65	Circulation, foyers, waiting rooms, restaurants, shops and cafes.
0.65 - 0.85	Laboratories, theatres, offices, plant rooms, audiological rooms.

AcoustiShield for Noise Reduction and Aesthetics

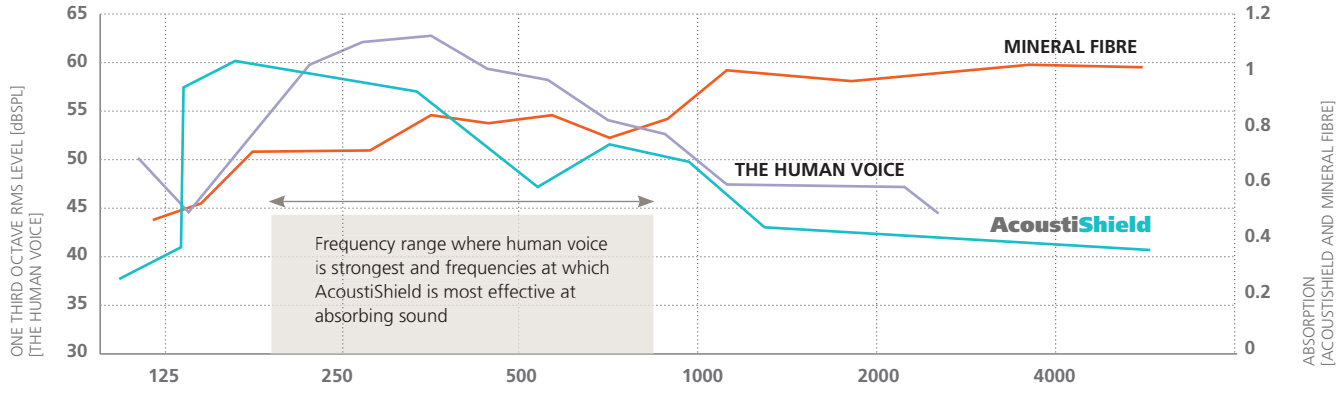
Lafarge Plasterboard recommends the installation of **AcoustiShield** to increase sound absorption in noisy areas such as in hotels and restaurants.

AcoustiShield can be used on walls and ceilings to achieve Noise Reduction Coefficients as high as 0.85. Available in three unique patterns, it adds to the design.

The advantages of using **AcoustiShield** include:

- Excellent sound absorption (controlling reflection)
- A unique aesthetic appearance provided by superior quality perforations
- A smooth finished surface provided by recessed edges
- Prevention of dust emission and improved sound absorption due to the protective mat fixed to the back of the plasterboard.

Together with the protective mat glued to the back of the board, the perforations in **AcoustiShield** are designed to absorb sound. The higher the rate of perforation, the higher the sound absorption performance and NRC value [REFER TO SECTION 4.7.2 FOR **AcoustiShield** SYSTEMS AND INSTALLATION REQUIREMENTS].



Source – Lafarge Gypsum Division Technical Development Centre.
Mineral Fibre ceiling tile (1200x600x20mm) on ceiling grid with plenum of 25cm (NRC 0.95).

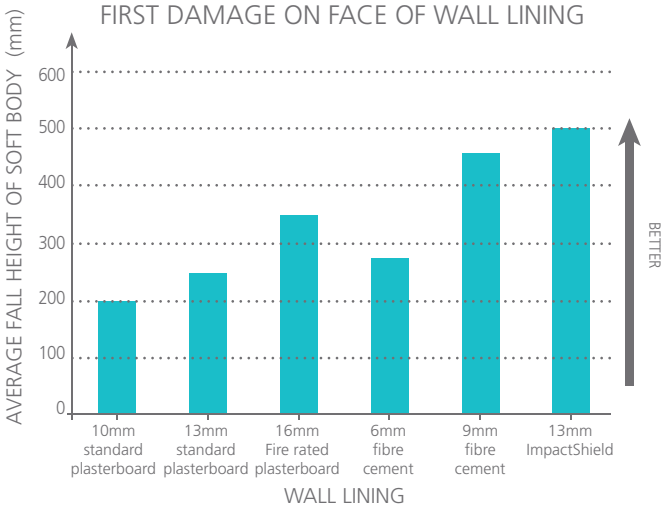
IMPACT RESISTANCE

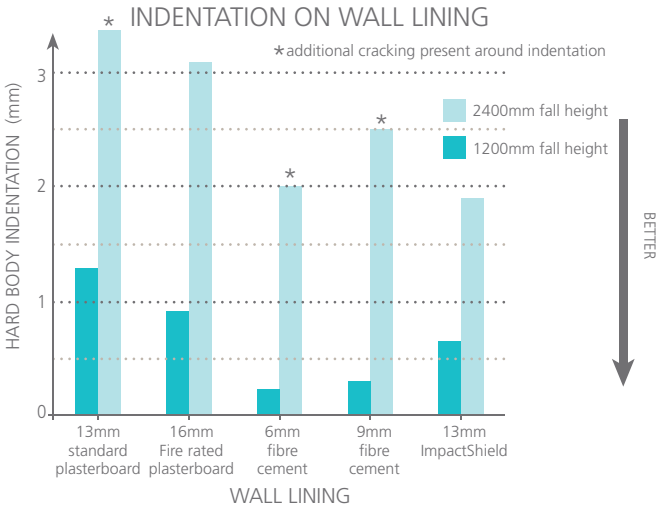
Areas subject to wear and tear need special consideration to reduce damage and maintenance costs. High traffic and wear areas are commonly found in:

- Shopping centres
- Educational facilities
- Hotels
- Airports
- Correctional centres
- Hospitals
- Garages
- Home gyms
- Corridors
- Rumpus rooms

Testing of Impact Resistant Linings

Both soft and hard body impact tests were used to measure the performance of various wall linings. The results are displayed in the graphs below.





Soft body tests were carried out by swinging a sand filled bag into a test wall according to BCA *Specification C1.8* with studs at 600mm centres. Soft body tests simulate the kind of loads applied to a wall system by the human body.

Hard body tests were carried out by dropping a steel ball from different heights and measuring the depth of the indentation caused by the impact. Hard body tests simulate loads such as a trolley or swinging a heavy suitcase.

Two conditions were measured for each of these tests:

- The damage on the face and back of the wall lining
- The depth of indentation.

ImpactShield for Impact Resistance

Lafarge Plasterboard recommends the installation of **ImpactShield** and **QuadShield** to minimise wear and tear in high traffic areas.

ImpactShield and **QuadShield** are impact resistant plasterboards reinforced with a continuous fibreglass mesh embedded in a high density core.

The benefits of **ImpactShield** and **QuadShield** include:

- High resistance to marks, scores, dents and holes
- Twice as tough and hard as standard 13mm plasterboard
- Economical and easy to repair.

13mm **ImpactShield** and 13mm **QuadShield** can be substituted for 13mm **FireShield** in any system and will maintain fire and acoustic performance.

ImpactShield and **QuadShield** are not intended to safeguard against damage from deliberate attack with heavy tools or in areas where heavy moving machinery may contact the walls (eg. unprotected forklift operating areas). Consider the following to minimise damage in high wear areas:

- Make thoroughfares as wide as practical
- Install doorstops on all door openings.

X-RAY RESISTANCE

Medical X-Ray diagnostic rooms require the use of protective barriers to shield operators and occupants of adjacent areas against unacceptable levels of X-Ray radiation.

The level of shielding required depends on:

- X-Ray workload and frequency of use
- Direction of X-Ray beam, voltage of X-Ray tube, number of exposures and X-Ray current
- Occupancy and usage of areas adjacent to X-Ray suites
- Position of the X-Ray unit and the controls in the room
- The dimensions of the room housing the equipment.

Protection usually takes the form of X-Ray absorbing sheet material on the walls of the room in which equipment is operated, together with suitably shielded windows and doors. X-Ray shielding may also be required on the floors and ceilings of X-Ray facilities in multi-storey buildings.

X-Ray resistance energy levels

X-ray radiation is measured in kilovolts peak (kVp). Depending on the type of radiation equipment used in the room, diagnostic facilities will have different requirements for shielding:

- CT 120-140 kVp
- General radiographic rooms 60-90 kVp
- Dental 60-80 kVp
- Mammography 25-35 kVp

Other facilities such as nuclear medicine suites may use higher energy X-rays or different types of radiation and additional shielding may be necessary. The level and quality of radiation differs between applications, therefore a Health Physicist must always be involved in determining the shielding requirements for X-ray diagnostic facilities.

Every Australian State and Territory has specific requirements for radiation shielding of diagnostic medical facilities. A Health Physicist or Radiation Consultant will be involved on projects to ensure that the local requirements for radiation shielding are fulfilled, according to the regulations of the State or Commonwealth.

Lafarge GIB X-Block® for Radiation Shielding

Lafarge Plasterboard recommends the use of **GIB X-Block®** systems to provide X-Ray radiation protection in medical X-Ray diagnostic rooms within medical facilities and dental clinics.

GIB X-Block is a lead-free plasterboard system with high levels of barium sulphate which provides an effective radiation barrier. It eliminates the need for costly and complex installation procedures usually associated with installing lead based lining solutions.

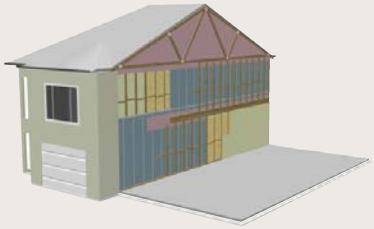
GIB X-Block systems use **GIB X-Block** jointing compound, a compound specifically designed to give lead equivalent joints on walls and ceilings using **GIB X-Block** plasterboard.

The advantages of using **GIB X-Block** Shielding systems:

- Lead free and environmentally friendly
- Easy to install and joint as standard plasterboard
- Enhances other important performance requirements such as noise control and fire ratings
- Eliminates the need for backing joints with lead strips.

SEPARATING WALLS

The BCA has specific fire and acoustic requirements for separating walls for side-by-side residential dwellings, such as duplexes and townhouses. Traditional solutions, like masonry and double stud systems are time consuming and complicated to construct. Builders require simple solutions that minimise the risk of reducing fire or acoustic performance due to construction details.



InterHome for simple and safe separating walls

Lafarge Plasterboard recommends **Inter**HOME™ to satisfy the fire safety and sound insulation requirements of the BCA for separating walls. The range of timber and steel stud **Inter**HOME systems cover; requirements for class 1a, 1b and 10a buildings, wet area solutions and high performing acoustics.

Fire protection performance:

- Fire Resistance Level (FRL) 60/60/60.

Sound insulation performance for separating walls of:

- Rw + Ctr 50 + Discontinuous Construction (All states and territories except NT)
- Rw 50 + Impact Sound (for NT only).

Sound insulation performance for soil and waste pipes of:

- Rw + Ctr 25 and Rw + Ctr 40
- Rw 30 and Rw 45.

InterHOME has the following advantages due to the modular central fire barrier:

- Fast to build
- Eliminates the need for timber blocking
- Allows both wall cavities to carry services without compromising fire or acoustic performance
- Outer layers of plasterboard are installed to non-fire rated installation methods
- Penetrations in outer layers are not required to be fire rated.

InterHOME can be constructed by the site carpenters at the same time as the framing is erected. It is quick, economical and importantly, designed to manage health and safety concerns with respect to ease of construction.

SUPERIOR LEVEL 4 FINISH

Modern architecture and design requires a high and consistent level of finish. Premium projects require the best finish that quality installation practices and materials can provide. The Australian standard for plasterboard installation AS/NZS 2589:2007 *Gypsum linings – Application and finishing*, define three Levels of Finish. The default Level of Finish is Level 4 [REFER TO CHAPTER 5.1 LEVELS OF FINISH].

A Level 4 Finish consists of a plasterboard wall or ceiling with a compound joint. This results in a number of different surfaces for the paint to cover; the paper face of the plasterboard, the compound surface, and the interface between these two zones.

As each of these surfaces present varying textures and porosity, the paint will be absorbed at different rates. These types of surface variations can result in different levels of sheen, gloss and the appearance of the paint colour.

MastaDeco with Level+ Technology to achieve the best possible Level 4 Finish.

Lafarge Plasterboard recommends the use of **MastaDeco** with Level+ Technology for any area that requires a premium finish, in residential and multi-residential developments, and commercial construction.

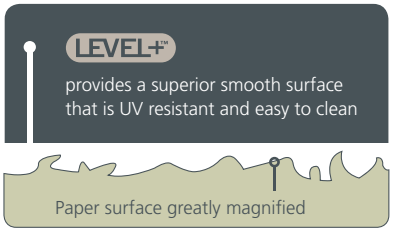
MastaDeco is ideal for walls and ceilings of foyers, large ceiling areas, drop down bulkheads, and hallways.

The unique Level+ Technology coating results in a smooth, UV resistant surface. The **MastaDeco** plasterboard and compounds combine to give a great match of surface texture and absorption of paint. This results in an even visual and material blend between board surface and joint.

Level+ Technology is an exclusive technology which has been developed by Lafarge through intensive research at the Gypsum International Technical Development Centre. Used worldwide, the system is fully patented and unique to Lafarge.

The benefits of **MastaDeco** with Level+ Technology:

- Design solution for flat and smooth surfaces
- A higher quality surface for painting and a superior appearance that is UV resistant and easy to clean
- No specialist equipment required for installation or jointing.



Fixing of **MastaDeco** plasterboard is the same as standard Level 4 Finish, as is the 3-coat jointing process with **MastaDeco** compounds. The complete **MastaDeco** system must be used to deliver the benefits of Level+ Technology [REFER TO SECTION 4.7.3 FOR MASTADECO INSTALLATION REQUIREMENTS].