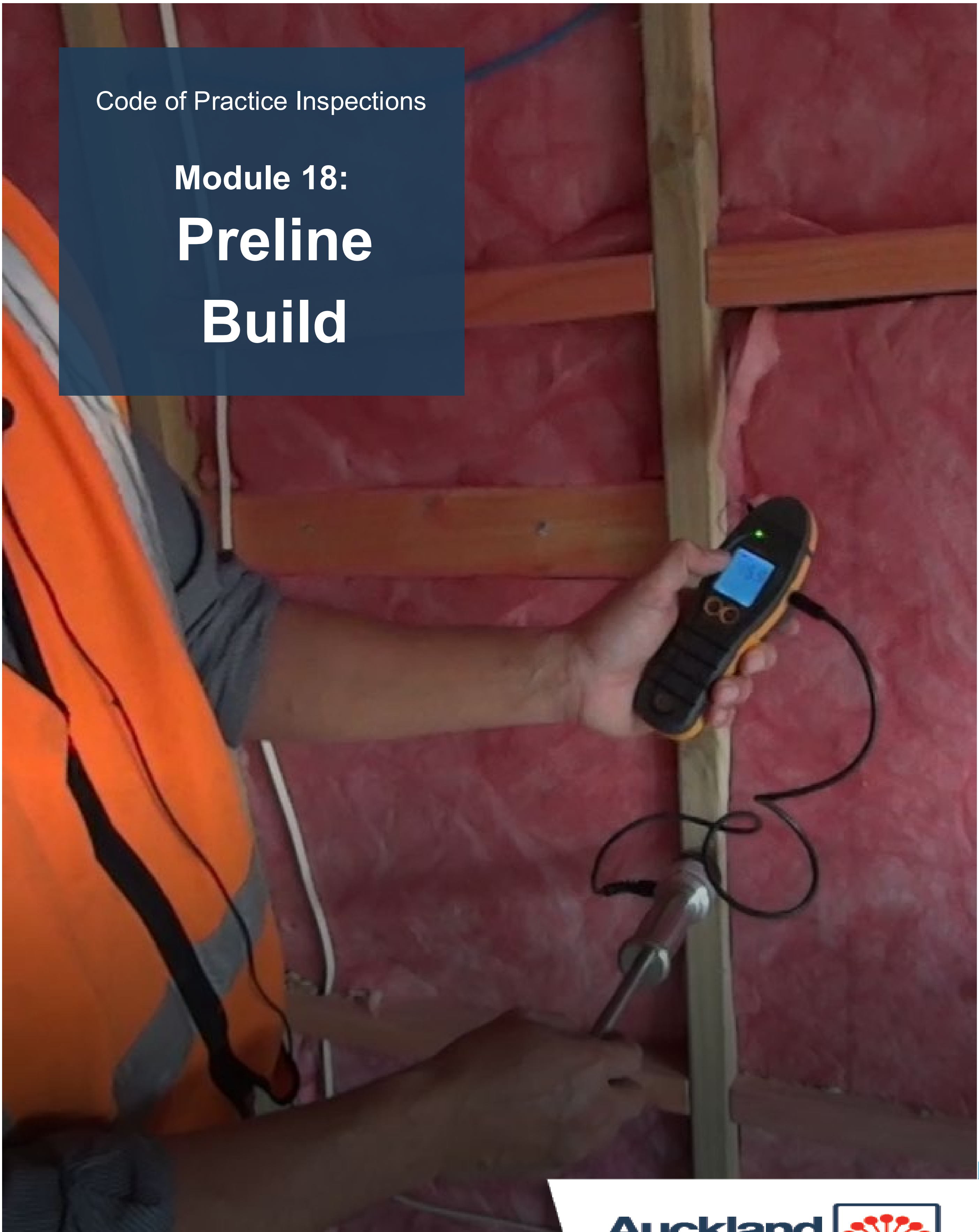
Code of Practice Inspections

Module 18: Preline Build



Auckland Council
Te Kaunihera o Tāmaki Makaurau

Contents

Purpose of a Preline Build Inspection

The purpose of a preline building inspection is to ensure that buildings and building elements are able to withstand the combination of loads that they are likely to experience during construction or alteration, or throughout their lives; and that buildings are constructed to provide adequate resistance to penetration by, and the accumulation of moisture, from the outside.

What documents hold technical information

Detailed technical information and guidance is available in the documents listed below. Always access these electronically (rather than hard copies) to ensure the reading of the most recent version. The inspection tablet will update automatically (when logging on after powering off/on).

- NZ Building Code: **Clauses: B1, B2, C1-6, D1, E1, E2, E3, F1, F4, F5, G4, G6, G12, G13, H1.**
- NZ Standard: NZS 3500.2.2018 **Plumbing and Drainage**
- NZ Standard: NZS 3602:2003 **Timber and Wood-based Products for Use in Building.**
- NZ Standard: NZS 3604:2011 **Timber framed buildings**.
- NZ Standard: NZS4223.3:2016 **Glazing in buildings**
- NZ Standard: NZS4515:2009 **Fire sprinkler systems for life safety in sleeping occupancies (up to 2000m^2)**
- NZ Standard: NZS4517:2010 **Fire sprinkler systems for houses**
- NZ Standard: NZS4541:2013 **Automatic fire sprinkler systems**
- NZ Standard: NZS1905.1:1997 **Components for the protection of openings in fire-resistant walls**
- NZ Standard: NZS4211:2008 **Specification for performance of windows**
- NZ Standard: NZS4246:2016 **Energy efficiency- Installing bulk thermal insulation in residential buildings**
- NZ Standard 5807:2008 **Code of practice for Industrial Identification By Colour, Wording, Or Other Coding**
- BRANZ Build Right, Build magazine April/May 2004

General overview

The pre-line inspection cannot be undertaken until the cladding inspection has been completed, e.g. the building must be weathertight, all exterior joinery must be fitted, no internal linings should be in place.

Electrical and plumbing fitouts must be completed before approval of building pre-line can be given. This is because the work involved with these trades may impact on the structural integrity or weathertightness of the building

Most building owners have difficulty visualising off the plans, for this reason it is not uncommon for changes to be made, e.g. window sizes increased or decreased, walls moved, etc. Amendments to the approved plans must be identified, recorded and plans altered to reflect these changes. Generally, this should have been identified at an earlier inspection, however it is possible changes are still being made at this stage in the building project.

Figure above: preline build inspection unachievable because building is not weathertight.

Preline

Figure above: Checklist line item 'Preline: framing notches and holes'

Holes and notches to joists

Holes must be drilled within the middle third of the joist; the hole can be 1/5 the depth or 32mm whichever is less. Anything beyond these dimensions will require specific design.

For example:

- if joist is 150mm (1/5 of 150 = 30mm) OK
- if joist is 200mm(1/5 of 200 = 40mm) Specific design >32mm
- if joist is 250mm(1/5 of 250 = 50mm) Specific design >32mm

The hole should be located not more than 3 x the depth of the joist, from the face of a support. For example, if the joist is 150mm and the hole is 32mm, then the hole must be located between 96mm and 450mm of the face of a support, e.g. wall.

Notches are permitted in the **bottom section** of a joist and comprise the same dimensions as for holes. For example, a 200mm joist may have a notch 40mm deep (note this requires specific design as it is >32mm). Notches must be located within 450mm of the face of a support, e.g. wall.

An alternative solution for accommodating holes in joists is the use of a proprietary product. The critical area of inspection with this product is that the bracket sits tightly against the joist and is installed as per the manufacturer's specifications. They are also only suitable for internal use.

Refer to **COP Module 15 Framing** section '**Timber types'** in '**Timber wall framing'** and '**Holes in joists'** for more information.

Note under no circumstances are holes or notches permitted in the part of the joist that is cantilevered.

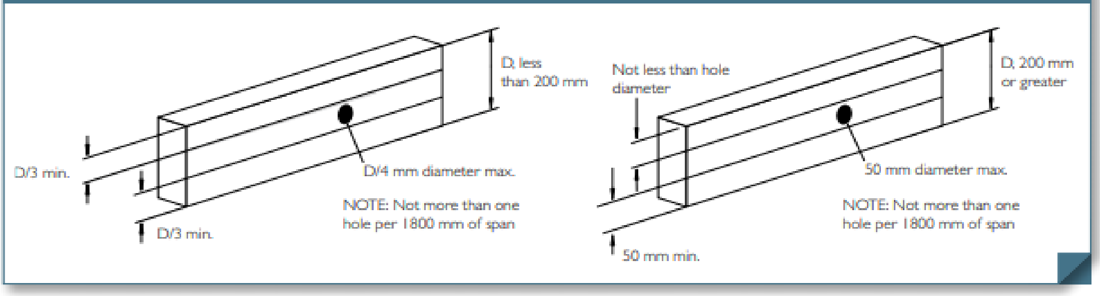
It is important for the inspector to check the manufacturer specifications for any holes to I-beam joists, and LVL joists, as each brand and type have different values.

Holes to LVL joists

6.3 HOLES IN MEMBERS IN HOUSES AND RESIDENTIAL BUILDINGS

Holes may be drilled in Futurebuild® LVL members used in houses within the scope of NZS 3604 as detailed below.

Figure 12: Holes in Futurebuild® LVL members



All treated Futurebuild LVL is envelope treated. Holes and cuts made in treated Futurebuild LVL must be coated with a brush on timber preservative. Holdfast Metalex End Seal is recommended.

CHH WOODPRODUCTS | FUTUREBUILD® LVL RESIDENTIAL DESIGN GUIDE | 0800 585 244 | www.chhwoodproducts.co.nz

Figure above: ‘hySPAN’ fixing details sourced form ‘CHH hySPAN’ specifications

Holes to I-beam joists

hyJOIST® OPTIONS RANGE

FIGURE 11: Circular & Rectangular Holes

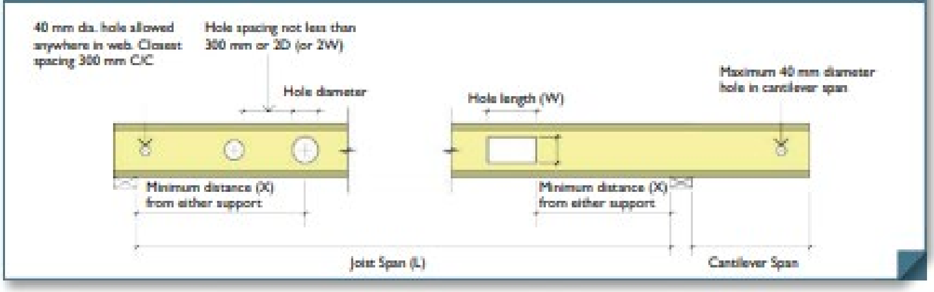
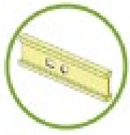
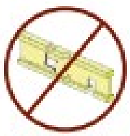


TABLE 5:

hyJOIST® section code	Maximum hole diameter (mm)	Minimum distance from support 'x'	Hole diameter (mm) Ø80	Ø110	Ø125	Ø150
			Circular holes – minimum distance 'x' from support – (m)			
HJ200 45	⌀118	0.34L[1]	0.16L	0.28L	N/A	N/A
HJ240 63	⌀158	0.38L	0.12L	0.21L	0.26L	0.33L
HJ240 90	⌀158	0.38L	0.12L	0.21L	0.26L	0.33L
HJ300 63	⌀218	0.41L	0.10L*	0.15L	0.18L	0.24L
HJ300 90	⌀218	0.41L	0.10L*	0.10L*	0.14L	0.20L
HJ360 63	⌀278	0.42L	0.3 m*	0.08L*	0.11L	0.16L
HJ360 90	⌀278	0.40L	0.3 m*	0.3 m*	0.3 m*	0.05L*
HJ400 90	⌀318	0.40L	0.3 m*	0.3 m*	0.3 m*	0.08L*



Do cut in web area as specified



Do not cut, notch or bore through flange

* Minimum distance from any support is 0.3 metres.
Example, if actual span 'L'= 4.0m then minimum distance 'X' from hole to support (see diagram) is 0.34 x 4.0 = 1.36m

TABLE 6:

hyJOIST® section code	Hole size Height (mm)	Length (mm)	Permitted locations for rectangular holes: L = Actual Span 'L' in metres; X = Minimum distance from the side of the hole to any support – (m)								
HJ200 45	118	250	L	≤ 3.8	4.0	4.2	4.4	4.5			
			X	0.34L	1.38	1.59	1.80	1.90			
HJ240 63	158	330	L	≤ 3.5	5.5						
			X	0.38L	2.13						
HJ240 90	158	330	L	≤ 5.8	6.0	6.1					
			X	0.38L	2.36	2.45					
HJ300 63	218	400	L	≤ 5.2	5.4	5.6	5.8	6.0	6.2	6.3	
			X	0.41L	2.25	2.39	2.54	2.69	2.83	2.91	
HJ300 90	218	400	L	≤ 6.4	6.6	6.8	7.0				
			X	0.40L	2.73	2.88	3.04				
HJ360 63	278	500	L	≤ 5.4	5.6	5.8	6.0	6.2	6.4	6.6	6.8
			X	0.42L	2.37	2.49	2.62	2.75	2.88	3.02	3.15
HJ360 90	278	500	L	≤ 7.2	7.4	7.6	7.7				
			X	0.40L	2.97	3.10	3.17				
HJ400 90	318	600	L	≤ 8.0							
			X	0.40L							

Interpolate to obtain values of 'X' for spans intermediate between the values given

Notes:

1. Data applies for floor joists supporting uniform loads (and concentrated live load not exceeding 1.8 kN).
2. Hole locations closer to supports may be possible for some load and support conditions; refer to the 'floor joist calculator' in designIT software or contact Carter Holt Harvey.
3. Spacing between holes to be not less than 300 mm or twice the width (or twice the diameter) of the larger hole.
4. Not more than three holes with width or diameter greater than 80 mm in any span.
5. For cantilever spans holes greater than 40 mm diameter are not permitted.
6. Not more than one rectangular (or square) hole per span.

CHH WOODPRODUCTS | hyJOIST® | 0800 808 131 | www.chhwoodproducts.co.nz | www.chhsoftware.com

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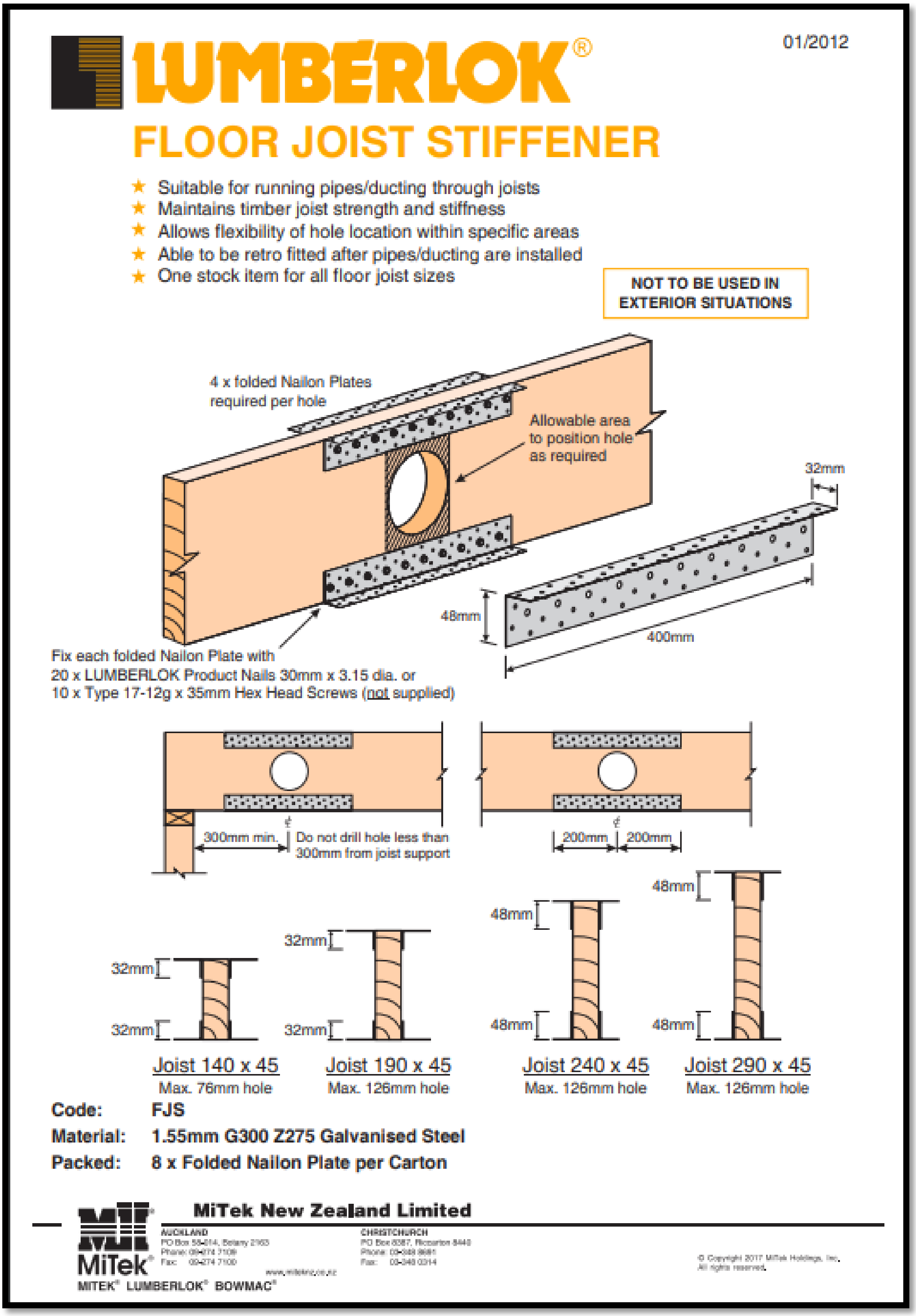
Figure above: table for hole positions for 'hyJOIST' sourced form 'CHH hyJOIST' specifications

Floor joist stiffeners



01/2012

LUMBERLOK®

FLOOR JOIST STIFFENER

- ★ Suitable for running pipes/ducting through joists
- ★ Maintains timber joist strength and stiffness
- ★ Allows flexibility of hole location within specific areas
- ★ Able to be retro fitted after pipes/ducting are installed
- ★ One stock item for all floor joist sizes

NOT TO BE USED IN EXTERIOR SITUATIONS

Code: **FJS**

Material: **1.55mm G300 Z275 Galvanised Steel**

Packed: **8 x Folded Nailon Plate per Carton**

MiTek New Zealand Limited

MITEK® LUMBERLOK® BOWMAC®

Figure above: sample of 'Lumberlok' joist stiffener from 'Mitek' specifications

Product Update

pryda

February 2011

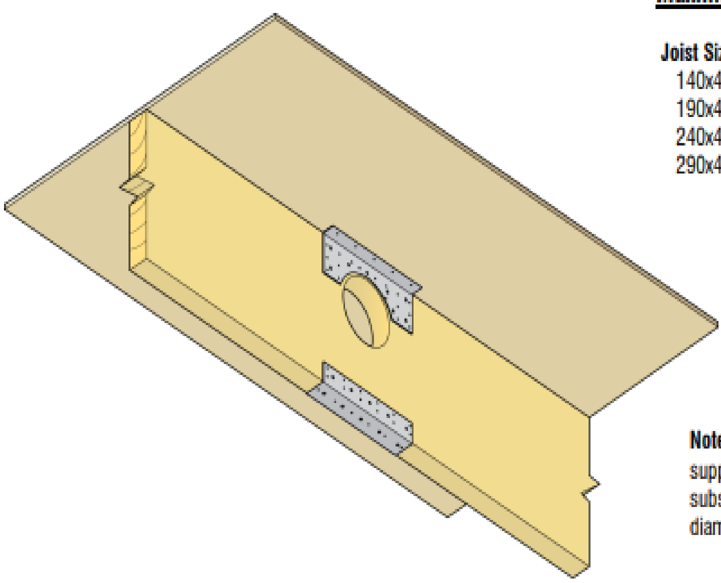
Pryda Stren-Joist

The Pryda Stren-Joist has been designed to allow holes to be cut in floor joists to enable pipes, wiring or other services to be passed through the joist. The fitting of a Pryda Stren-Joist re-instates the integrity of the penetrated joist.

Advantages:

- Quick and easy to install
- Fixing option of either nailing or screwing. Note—Fixing to the flooring must be done with screws provided. All other holes can use either nails or screws
- Can be retro-fitted. There is no requirement to remove services to fit the Stren-Joist
- Comes in one size, designed to fit 140—290mm joists
- Allows an easy solution to fix penetrations in floor joists made by other trades
- Timber grade can be MSG8 or better
- The edge of the penetration shall be at least the joist depth from the end of the joist
- All components are available in a single kit - **Pryda Code NPSJ**

Each kit contains: 1 x 'U' channel, 2 x arched angles, 1 x 500gm of Pryda Product Nails and 10 /8g x 20mm screws. (If the hex screw fixing option is used then 30 /12g x 35mm hex head type #17 galvanised screws are required. Not supplied)



Maximum Joist Penetration (mm)

Joist Size	Max Hole size
140x45	72
190x45	122
240x45	125
290x45	125

Note: Pryda Product nails (30x3.15mm) supplied with the kit are not to be substituted with nails of a lesser diameter such as standard clouts.

Figure above: sample of 'Pryda Stren-Joist' joist stiffener from 'Pryda' specifications

BRACE iT LTD

Distributing innovative **THRU-BRACKET™** solutions

BRANZ Appraised
Appraisal No. 570 (2014)

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THRU-JOIST™
(TJ)

- THRU-JOIST™ brackets enable holes to be cut up to 121mm diameter in flooring joists to allow services to run through the mid floor and other enclosed areas, without affecting the strength and stiffness requirements of a joist under NZS 3604:2011 and AS 1684.2-2011 (For Radiata Pine up to and including stress grades F8).
- No limitation on where THRU-JOIST™ brackets may be installed along the length of joist.
- Multiple THRU-JOIST™ brackets may be used on the same joist (refer fixing note).
- Alternative BRANZ Appraised Solution to NZS 3604:2011 and Australian Standard AS 1684.2-2011.
- THRU-JOIST™ brackets are a very cost effective, simple to install building method to allow services to run through joists.

Bracket	Max Hole size
140mm x 45mm (TJ140)	68mm
190mm x 45mm (TJ190)	121mm
240mm x 45mm (TJ240)	121mm
290mm x 45mm (TJ290)	121mm

Fixing Notes

CAD Files

Comparison Chart

NZ Reg. Design	Aust. Reg Design
App 410058 - 2007	318486
410059 - 2007	318487
410060 - 2007	318488
410061 - 2007	318489

TJ140 (for 140 x 45mm joist)
TJ190 (for 190 x 45mm joist)
TJ240 (for 240 x 45mm joist)
TJ290 (for 290 X 45mm joist)

Figure above: sample of 'Thru-joist' stiffener from 'BRACE iT Ltd' specifications

Holes and notches in bottom plates

Where holes or face notches exceed 50% of the width of the bottom plate, fix the plate against sideways movement on each side of the hole or notch, with one 100mm x 3.75mm nail for timber floor, or for concrete floor, a 75mm concrete nail with washer or proprietary bolt, both sides.

Holes and notches in top plates

70mm x 45mm = 19mm diameter or depth (max. 200mm length)
90mm x 45mm = 25mm diameter or depth (max. 200mm length)

Where holes or notches exceed these parameters, the top plate must be strengthened.

NZS3604 allows for the plates to be strengthened by one of the following methods;

- A 70mm x 45mm member x 600mm long nailed to the exterior side of the plate with 4/75 x 3.15 nails on each side of the hole or notch
- A 70mm x 45mm eaves runner connected to all studs and no more than 250mm below the top plate
- A 70mm x 45mm blocking fitted between ceiling joists or trusses above cut top plates and the steel angle 40 x 40 x 1mm 600mm long fixed with 6/75 x 3.15mm nails each side of the hole or notch

Otherwise a propietary plate stiffener can be used.

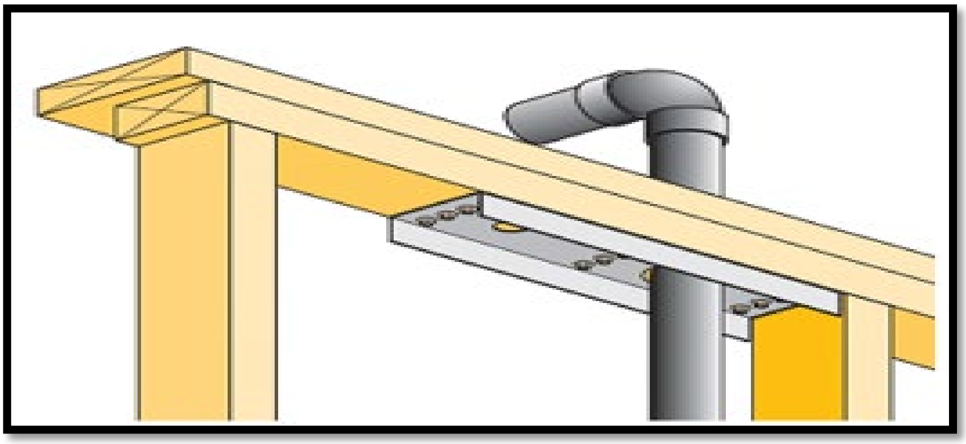


Figure above: sample of proprietary plate stiffener; this example from Mitek.

Holes and notches to trusses

Trusses shall have no cuts, notches or holes drilled in them. Builders often cut the top chord to accommodate valleys. If a truss has been cut or damaged in any manner an engineer must verify in writing that the integrity of the truss has not been affected.

Holes and notches to studs

Holes and notches to studs:

- 70mm stud: 19mm (maybe increased to 22mm for fitting a metal angle brace)
- 90mm stud: 25mm (maybe increased to 35mm when not more than 3 consecutive studs are drilled or notched)
- trimming studs must not be drilled or cut in their middle 1/3.

Where notches and holes are more than the above tolerances, a proprietary stud stiffener shall be used.

Building weathertight

Figure above: Checklist line item ‘Preline building- cladding complete and building weatherproof’

The building should be weathertight for a pre-line inspection to be undertaken. The inspector is to check that all wall and roof cladding is complete, all joinery is installed, and the external envelope of the building is complete.

All penetrations must be sealed with a durable flashing and sealant.

All roof penetrations must be flashed with durable and compatible components. Sealant is added as a secondary measure only, the flashing or boot being the primary mechanism for achieving weathertightness.

All meter boxes (gas and electrical) must be flashed with the flashing extending across the top and down the sides of the appliance to shed water away from the cladding.

Joinery

Figure above: Checklist Parent line item ‘Preline: joinery installed and air sealed’

Note: When completing this parent line item, consideration must be given to cover all relevant child line items.

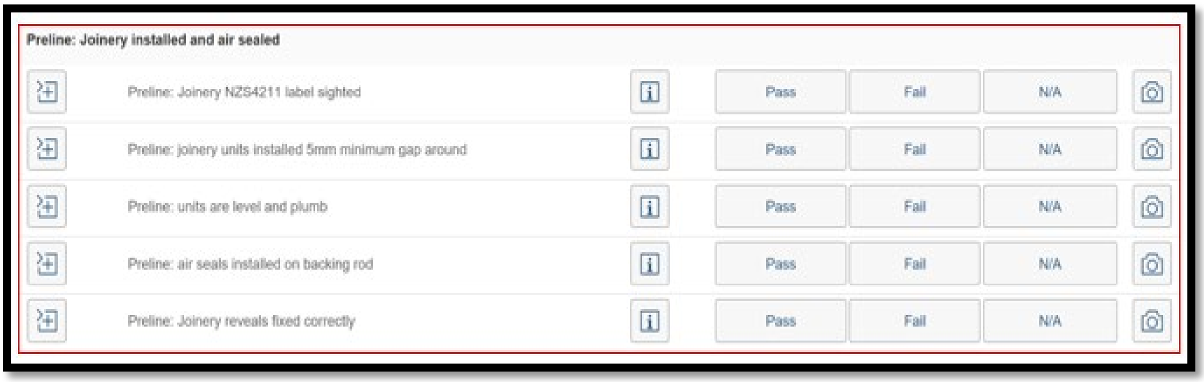


Figure above: Checklist Child line items

NZS4211 requires all window and door units be labelled. All joinery claimed by the manufacturer to comply with NZS4211 shall be marked on the frame in letters not less than 2mm high with:

- the manufacturer’s name or brand number
- NZS4211:2008
- the rating expressed as the appropriate wind zone or wind pressure, or the ULS pressures in the case of specific design up to extreme
- the air infiltration level

The marking shall be on the framework member, or on a durable affixed label, readable after installation.

Each opening window unit should be labelled in the stay cavity, immediately below the left-hand side stay.

Figure above: sample of joinery labels sourced from Nulook joinery.

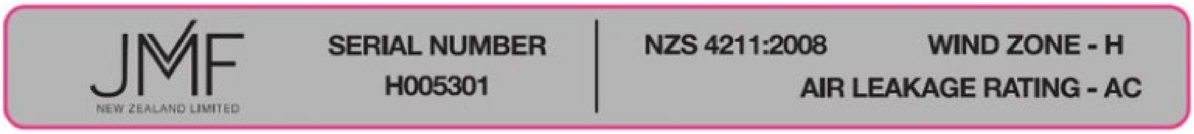


Figure above: sample of timber joinery label

Any timber joinery without this label needs to be certified by the manufacturer for compliance.

When checking the joinery, double check to make sure the opening is as per plan. This check should already have been conducted at the framing inspection but because the joinery is not installed at that time or may have changed. This check is quite important to capture those changes.

Install aluminium windows and doors using pairs of minimum 75 x 3.15 galvanised jolt head nails or 8-gauge x 65 mm stainless steel screws, through reveals into surrounding framing at maximum 450 mm centres along sills, jambs and heads, 150 mm from reveal ends. Install packers between reveals and framing at all fixing points, except between head reveals and lintels. The jamb packers should be cut minimum 10mm behind the frame edge to allow for a continuous pressure seal.

Joinery requires a minimum 5mm gap between the framing and joinery so that a pressure seal (expandable foam) is fitted to prevent air-leakage. A foam insert (pef rod) should be installed before the sealant is applied. This stops the expandable foam from filling the entire depth of the cavity between the joinery and the frame. It is crucial that the entire depth of the cavity is not filled, as this will cause wicking of moisture to occur.

Glazing

Figure above: Checklist Parent line item 'Preline: window/door glazing permanent markings sighted'

Note: When completing this parent line item, consideration must be given to cover all relevant child line items.

Figure above: Checklist Child line items

Glazing in wet areas within 2m of the floor must be safety glass and must be etched to verify this. If the bathroom has been refurbished, the glazing must be upgraded to comply with the Building Code. If safety glass is not permanently etched, it cannot be accepted. NZS4223 requires the marking to be permanent and visible, e.g. stickers and producer statements are **not acceptable**.

Each pane of safety glass shall be marked with the following minimum requirements:

- The name or registered trademark of the manufacturer or supplier.
- The type of safety glass. This may be in the form of a code from the relevant standard, e.g. T= toughened, L= laminated.
- The standard to which the safety glass has been manufactured and tested, e.g. AS/NZS 2208.
- The license or identification number provided by the third-party compliance certifier for the plant of manufacture or processing, where applicable as a means of compliance for the relevant standard.

Figure above: sample of safety glass markings (Metro Glass Tech)

Louvres in all human impact locations, within 2m of the floor, shall be safety glass not less than 5mm thickness.

Similarly, where there are large sheets / panes of glass fitted, or where the location is high-risk such as stairwells, barriers, etc., then safety glass will be required.

Glazing within 2000mm vertically of any part of a stairway, ramp, or landing shall be as follows:

- Glazing adjacent to a stairway, ramp, landing and within 1000mm horizontally of the walking surface shall be safety glass.
- Glazing within 2000mm horizontally and at right angles to the bottom riser of each stair flight shall be safety glass.
- Glazing in stairways, ramps, and landings that is behind and protected by a compliant barrier, and is within 1000mm horizontally from the barrier, shall be safety glass.

Note: Glazing more than 1000mm horizontally from the top of the barrier is not considered be high risk.

Glazing within 800mm horizontally and 2000mm vertically of the nearest edge of a doorway opening shall be safety glass. Glazing that is either curved or has an angle greater than 30° of the plane of the closed door shall be safety glass.

For early childhood centres, glazing wholly or partly within 800mm of the FFL, ground, or deck level shall be safety glass.

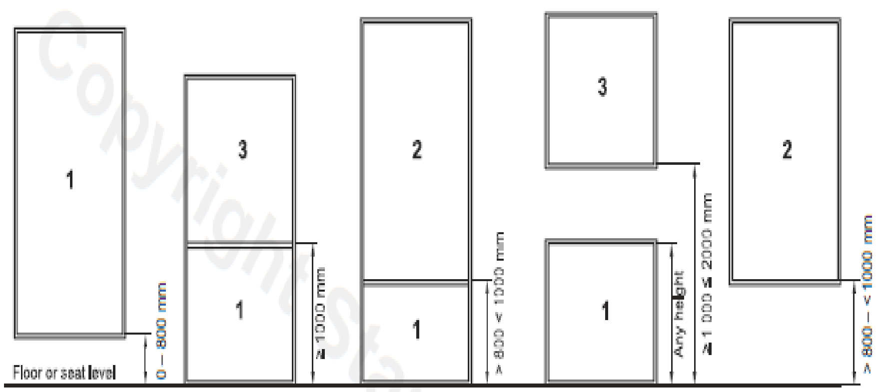
For primary and secondary schools, glazing wholly or partly within 200mm of the FFL, ground, or deck level shall be safety glass.

Glazing wholly or partly within 2000mm vertically and within 5000mm horizontally of the walking surface of sports courts or marked fields shall be safety glass.

Glazing wholly or partly within 2000mm vertically and within 2000mm horizontally of the walking surface alongside spa pools and swimming pools shall be safety glass.

Glass used in balustrades, fences or screens shall be toughened or laminated safety glass. Balustrades, fences and screens that safeguard a fall of 1000mm or more from the floor, deck or balcony level are defined in the NZ Building Code as a barrier and shall meet the requirements of F4 and resist the actions from AS/NZS 1170.1 in accordance with VM Method B1/VM1 of Clause B1.

Table 7 – Fully framed glazing safeguarding a fall of 1000 mm or more



Glass selection table			
Occupancy type	**Pane 1**	**Pane 2**	**Pane 3**
(AS/NZS 1170.1)	Designed to uniform infill load and human impact	Designed to uniform infill load and human impact	Designed to wind pressure and human impact
A (within private dwelling)	Safety glass to Table 1. Minimum 4 mm toughened or 6 mm laminated	Safety glass to Table 1 or annealed glass to Table 2 (5 mm minimum)	Safety glass to Table 1 or annealed glass to Table 2. Check ULS wind pressure of 1.36 kPA
A (other), C3, B, & E	Safety glass to Table 1. Minimum 4 mm toughened or 6 mm laminated	Safety glass to Table 1 or annealed glass to Table 2 (6 mm minimum)	Safety glass to Table 1 or annealed glass to Table 2
C1/C2, D, & C5	Safety glass to Table 1. Minimum 5 mm toughened or 8 mm laminated	Safety glass to Table 1. Minimum 4 mm toughened or 6 mm laminate	Safety glass to Table 1

Figure above: NZS4223.3.2016 table 7, Fully framed glazing safeguarding a fall of 1000mm or more

Fire resistant glazing

Fire resisting glazing means fixed or opening glazing, complete with frame, fixings, mullions, transoms and glazing beads, with a specified fire resistance rating.

Every glazing panel that consists of unwired glass with fire resistant qualities shall incorporate a permanent identification mark.

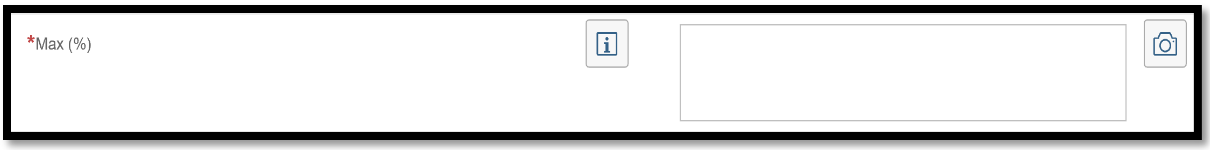
The required information shall be etched, embossed or stamped on a metal label so that it is recessed or projected not less than 0.25mm below or above the surface of the label. Alphabetic or numeric characters shall not be less than 1.5mm high.

The label shal preferably be located at the top internal corner of all fire window frames or other reasonable, yet visible internal location, fixed to not compromise sash clearances, and be able to withstand 890°C.

Figures above: samples of fire glazing markings.

Timber moisture

Refer to Module 2 ‘Equipment and Safety’ for instruction on how to use a moisture meter.



Figures above: Checklist Parent line item ‘Preline: Timber framing moisture content 18% maximum’

Note: When completing this parent line item, consideration must be given to cover all relevant child line items.

Figure above: Checklist Child line items

Check a minimum of 6 readings of the listed items and record the range of readings: lintels, bottom plates, floor joists and studs located around the perimeter of the building, and ceiling battens and floor joists throughout the building.

Acceptable moisture content is when 5 out of the 6 test samples indicate moisture levels with a maximum reading of 18%. One reading may be maximum 20%. Sometimes more readings are required in larger buildings. As a general guide, 6 readings should sufficiently cover a typical single storey 3-4-bedroom house.

Moisture content at the bottom of studs and bottom plates are generally higher due to gravity drawing moisture downwards. It’s commonly accepted to test studs 400mm up from the bottom of the studs and ends of the bottom plates on the middle of the top face. Pins inserted along the grain.

Moisture meters should be handled with care to prevent damage and or faulty readings. All meters have calibration checked at time of equipment audit.

The correction tables listed should be used to confirm readings to ensure accuracy, e.g. a meter reading of 21% or less, the actual moisture content of the H1.2 pine will be 18% or less.

In addition to this chart, if any inspector has any questions in relation to readings whilst onsite, they can refer to their team leader

Engineered timber such as LVL and CLT require specific corrections to be applied due to different make-up properties of the framing. Example below, is the Scion correction table for J-Frame LVL.

When inspectors come across other engineered framing, they must use the manufacturers' guidance for testing moisture.

For J-Frame LVL timber, drive the sliding hammer electrode into the framing with the probes aligned parallel to the wood grain into the inner side of the studs, crossing the glue lines, and driven to 1/3 of the thickness of the timber being measured (e.g. 15mm for 45mm thick J-Frame LVL). From the Scion moisture content of J-Frame table, a moisture meter reading of 28.7 converts to an acceptable moisture content reading of 18% in line with Winstone Gib installation requirements.

J-Frame moisture reading conversion table

Te Papa Tipu Innovation Park
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Telephone +64 7 343 5899 | Facsimile +64 7 348 0952
E mail enquiries@scionresearch.com | www.scionresearch.com

SCION forests·products·innovation

JNL JUKEN NEW ZEALAND LTD

RECOMMENDED PROCEDURE FOR TESTING MOISTURE CONTENT OF J-FRAME LVL, December 2018

These notes have been prepared to guide building inspectors and others testing the moisture content of Boron treated J-Frame LVL, for use where Hazard Class H1.2 or less applies. LVL from other manufacturers may have different values in Table1.

For a resistance type moisture meter

1. It is recommended that a sliding hammer type electrode is used to test the moisture content of framing.
2. The resistance moisture meter should be calibrated to the New Zealand calibration standard (AS/NZS 1080.1).
3. Drive the sliding hammer electrode into the framing, with the probes aligned parallel to the wood grain, crossing the glue lines as seen in the photograph, and driven to 1/3 of the thickness of the timber being measured (e.g. 15 mm for 45 mm thick J-Frame LVL).
4. Take the measurement, and note the meter reading.
5. Select the acceptable moisture content value in Table 1 (for example 20%).
6. If 9 out of 10 readings are less than or equal to the corresponding meter reading, the required standard will be met (For example if 20% is the acceptable value, 9 out 10 meter readings must be 36.5 or less).

TABLE 1: Table for converting resistance moisture meter readings to true moisture content for Boron treated J-Frame LVL, for use where Hazard Class H1.2 or less applies, if 10 readings are made

Acceptable moisture content for closing the building															
10	11	12	13	14	15	16	17	18	19	**20**	21	22	23	24	25
Meter reading for Boron J-frame LVL, for use where Hazard Class H1.2 or less applies.															
12.2	12.7	13.9	15.4	17.3	19.6	22.3	25.4	28.7	32.4	**36.5**	41.0	45.7	50.8	55.9	61.9

This table can be used to ensure moisture content of 9 out of 10 boards are below an acceptable moisture content.

This document is an interim document issued in Dec 2018 pending the release of an improved testing procedure that will more accurately comply with NZS 3602:2003. For more information on the general use of moisture meters (no LVL corrections), refer to BRANZ Bulletin BU585; Measuring moisture content in timber and concrete.

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Timber moisture correction table for various species timber species

Correction figures for resistance type moisture meters*

Species	Type of wood and Treatment		10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
			Average Corrected Moisture Content														
Radiata pine	Sap	Untreated	12	12	13	14	15	16	17	18	19	20	21	22	23	24	25
	Sap	**Boron**	**11**	**11**	**12**	**12**	**13**	**13**	**14**	**15**	**16**	**16**	**17**	**18**	19	20	21
	Sap	**Tanalith**	**10**	**11**	**12**	**12**	**13**	**14**	**14**	**15**	**16**	**17**	**18**	19	19	20	21
	Sap	**LOSP***	**13**	**14**	**15**	**16**	**17**	**18**	19	20	21	22	23	24	25	26	28
Douglas fir (NZ grown)	**Sap**	**Untreated**	**12**	**13**	**14**	**15**	**16**	**18**	19	20	21	22	24	25	26	27	28
	Heart	**Untreated**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**18**	19	20	21	22	23	24	25
Australian blackwood	Heart	Untreated	11	12	12	13	14	15	16	17	18	18	19	20	21	21	22
Black walnut	Heart	Untreated	11	12	13	13	14	15	16	16	17	18	19	19	20	21	22
Eucalyptus botryoides	Heart	Untreated	9	10	11	12	13	14	15	16	17	18	19	20	21	-	-
Eucalyptus fastigata	Heart	Untreated	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Eucalyptus globulas	Heart	Untreated	9	10	11	12	12	13	14	15	16	17	17	18	19	20	21
Eucalyptus muellerana	Heart	Untreated	11	13	14	15	16	18	19	20	21	22	24	25	26	-	-
Eucalyptus obliqua	Heart	Untreated	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
Eucalyptus saligna	Heart	Untreated	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Larch	Heart	Untreated	12	13	14	15	16	18	19	20	21	22	23	24	25	26	27
Lusitanica	Heart	Untreated	11	12	13	14	15	16	16	17	18	19	20	21	22	23	24
Macrocarpa	**Heart**	**Untreated**	**11**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**18**	19	20	21	22	23
Kahikatea	Mixed	Untreated	11	12	12	13	14	15	16	16	17	18	19	19	20	21	22
Matai	Sap	Untreated	12	13	14	15	16	16	17	18	19	19	20	20	21	21	22
	Heart	Untreated	11	11	12	13	14	14	15	15	16	16	17	17	18	18	19
Red beech	Sap	Untreated	10	11	12	13	14	15	16	17	18	19	19	20	21	22	23
	Heart	Untreated	12	13	14	15	16	17	18	19	20	21	22	22	23	24	25
Rimu	**Non heart****	**Untreated**	**12**	**12**	**13**	**14**	**15**	**16**	**16**	**17**	**18**	**19**	**19**	20	20	21	21
	Heart	**Untreated**	**11**	**11**	**12**	**12**	**12**	**13**	**13**	**13**	**14**	**14**	**15**	**15**	**16**	**16**	**17**
Silver beech	Sap	Untreated	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Tawa	Mixed	Untreated	11	11	12	13	13	14	15	15	16	17	17	18	19	19	20
Totara	Heart	Untreated	9	10	11	12	12	13	14	14	15	16	16	17	18	19	19
Redwood (Imported)	Heart	Untreated	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Western red cedar (imported)	Heart	Untreated	10	11	12	13	14	14	15	16	17	18	19	19	20	21	22

* These figures should only be used with a resistance type moisture meter calibrated to the standard resistance relationship in AS/NZS 1080.1

** Normally a mixture of sapwood and intermediate heartwood

*** Indicative values only-must be used with caution

Prepared by: NZ Forest Research Instute Ltd

Block wall strapping

Figure above: Checklist line item 'Preline: blockwall strapping'

If block walls or columns form part of the thermal envelope, they will require strapping with timber battens before lining can be fixed. Strapping should be fitted at 400-600 centres to suit lining material and be fixed over a damp-proof course to prevent moisture penetrating the timber. Generally strapping will be in the form of timber battens 45mm thick, in between which polystyrene or polyester will be inserted for insulation purposes.

If using polystyrene, special cabling must be used. Alternatively cables maybe sleeved in conduit to prevent damage. PVC electrical cables undergo plasticiser migration when in contact with polystyrene. This causes the polystyrene to shrink away from the cable and cable insulation to become brittle.

Winstone Gib allow plaster board to concrete block using the Rondo track system. Gib Rondo battens clipped to Gib Rondo A239 clips spaced at 1200mm centres vertically, and 600mm centres horizontally.

Stairs

Figure above: Checklist Parent line item 'Preline: stairs as per plan'

Note: When completing this parent line item, consideration must be given to cover all relevant child line items.

Figure above: Checklist Child line items

All stairs must be installed so that a minimum head height of 2.0m is achieved. Landings are required at the top and bottom of every flight of stairs except where there is a fall of less than 600mm in which case the landing can be omitted. If a landing is provided the minimum length is 900mm.

Stair	Maximum pitch	Maximum riser height	Minimum tread width
Service, minor private	47	220	220
Secondary private	41	200	250
Common & main private	37	190	280
Accessible	32	180	310

Figure above: sample of design limits for stairs D1/AS1 table 6

Riser height and tread depth for all steps in any one flight must be uniform with an allowable tolerance of ± 5 mm. The triangular opening formed by the riser, tread, and bottom rail of the barrier on a stair shall be of such a size that a 150mm diameter sphere cannot pass through it

If 3 or more steps are present a handrail must be fitted. Handrails must be graspable and provide sufficient room to prevent knuckles touching any adjoining surface. The height of a handrail is 900mm minimum and 1.0m maximum and is measured vertically, from the pitch line or stair nosing.

A barrier must be provided to landings and stairs where there is a fall of more than 1.0m, including a temporary barrier during the construction stage for the safety of everyone onsite. The inspector will check that barrier fixing requirements are provided as per plan. This may include specific engineer designed straps to lock-in boundary joists, additional brackets, etc. Nogs should be in place to accommodate the installation of the stair handrail.

Heights are measured vertically from finished floor level (ignoring carpet or vinyl, or similar thickness coverings) on floors, landings and ramps. On stairs the height is measured vertically from the pitch line or stair nosing.

If glazing is installed at the bottom of a flight of stairs, the glazing must be safety glass. See previous glazing section.

Wet areas.

Figure above: Checklist line item 'Preline: wet area substrate

Figure above: Checklist line item 'Preline: corner steel angles for tiles (plaster board only)'

Wet area floor substrate requires joists at 400mm centres. Suitable substrates include treated plywood, compressed fibre sheet, particle board, or concrete. Plywood and particle board shall be fixed with stainless steel screws at 150mm centres to the sheet perimeter, and 200mm centres to the rest of the sheet.

If using treated plywood, check to make sure treatment is suitable for adhesive. Ply substrate requires nog support (90x45mm on edge) at 400mm centres and to all ply joins.

Tiled shower walls over plasterboard require a 32mmx32mm x0.55mm metal angle to a minimum height of 1.8m before the plasterboard linings are installed. Each side of the angle shall be fastened to the framing with 30mm galvanised clouts at 300mm centres.

The inspector is to ensure nogs have been installed to the lip of the bath/shower base between the studs for plasterboard fixings. This is to ensure that there is no movement between the plasterboard and bath breaking the membrane seal later.

Roof space access.

Figure above: Checklist line item 'Preline: roof space access hatch size'

Each ceiling space within different levels of the building must be accessed and inspected. Manholes must be provided for each level of the building, additional access maybe provided through an external wall into a roof space. The minimum size for an access panel is 600mm x 500mm, with minimum 600mm clearance above the access point into the roof space.

Insulation

Figure above: Checklist Parent line item 'Insulation installation correct as per plan'

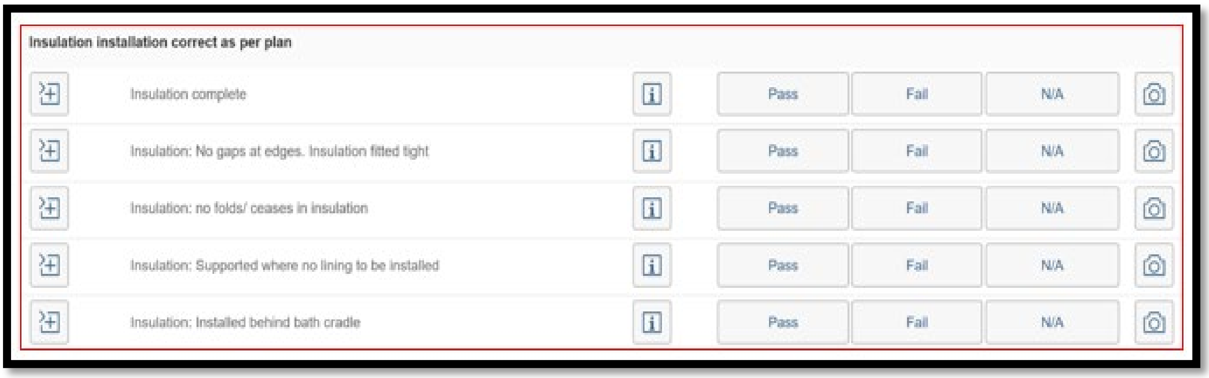


Figure above: Checklist Child line items

The purpose of an insulation inspection is to ensure that the building has an adequate degree of energy efficiency and that the thermal envelope of the building is constructed to provide thermal resistance and limit uncontrollable airflow.

A building consent is not required for retrofitting insulation into the roof or underfloor of existing houses but is required for retrofitting insulation into the external walls of houses.

When an inspector is at a house alteration and the owner has removed wall linings to install insulation, this must be on the building consent. If no building wrap is in place between the cladding and the framing, this will need to be carefully installed between the studs and nogs. For direct fix cladding, a 25mm airgap must be maintained between the wrap and the insulation.

Insulation is an important part of creating a dry and healthy home. Failure to install insulation correctly can cause problems with heat loss and energy efficiency. The goal of insulation is to slow down heat transfer.

The best insulation material can be ineffective if installed poorly. How well insulation is fitted is important, because heat can escape through small gaps or by thermal bridging. Gaps as small as a few millimetres around the edges of insulation can halve the overall thermal resistance.

In ceilings, gaps around the edges of insulation reduce the R-value of insulation by approximately 3% for every 1mm gap of 16mm around the edge, the effective R-value of the insulation is about half the nominal R-value (16 x 3%=48%).

It is important for the insulation product to achieve its nominal thickness. Compressing the insulation into a cavity smaller than the insulation's thickness will reduce its actual delivered R-value in almost direct relation to the amount compressed, e.g. when a product that is R2.0 at 100mm is compressed down to 80mm the result is an R-value of approximately 80% of R2.0, or R1.6

Insulation works by trapping air in cavities. The smaller the cavities of trapped air, the better the insulation material will work.   We can insulate our homes by providing cavities of still air, such as in wall insulation or double-glazing. This reduces heat transfer because air is a poor conductor of heat.

Insulation is designed in varying sizes, which enables it to be friction fitted between joists, trusses or wall studs. Insulation should always be cut slightly oversize to ensure a friction fit but not too large causing it to bulge.

The R-value measures how good the insulation material is at containing heat. The higher the R-value, the better the insulation value will be. The insulation needs to be properly installed to reach the R-value. Where required, walls behind baths and stairs must have insulation installed with no gaps.

Figure above: Checklist Parent line item ‘Type of wall insulation and ‘R’ rating as per plan’

Note: When completing this parent line item, consideration must be given to cover all relevant child line items.

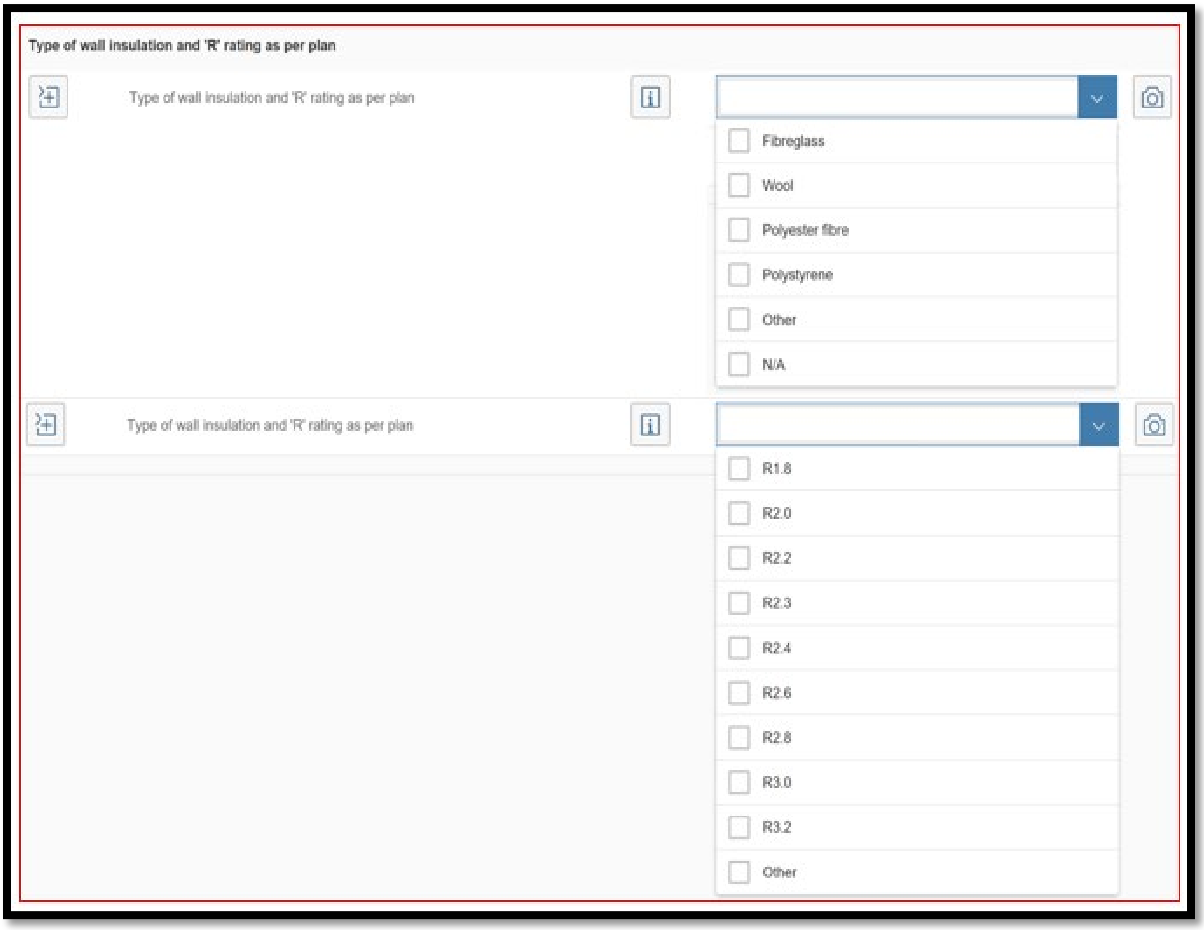


Figure above: Checklist Child line items

Figure above: Checklist Parent line item ‘Type of ceiling insulation and ‘R’ rating as per plan’

Note: When completing this parent line item, consideration must be given to cover all relevant child line items.

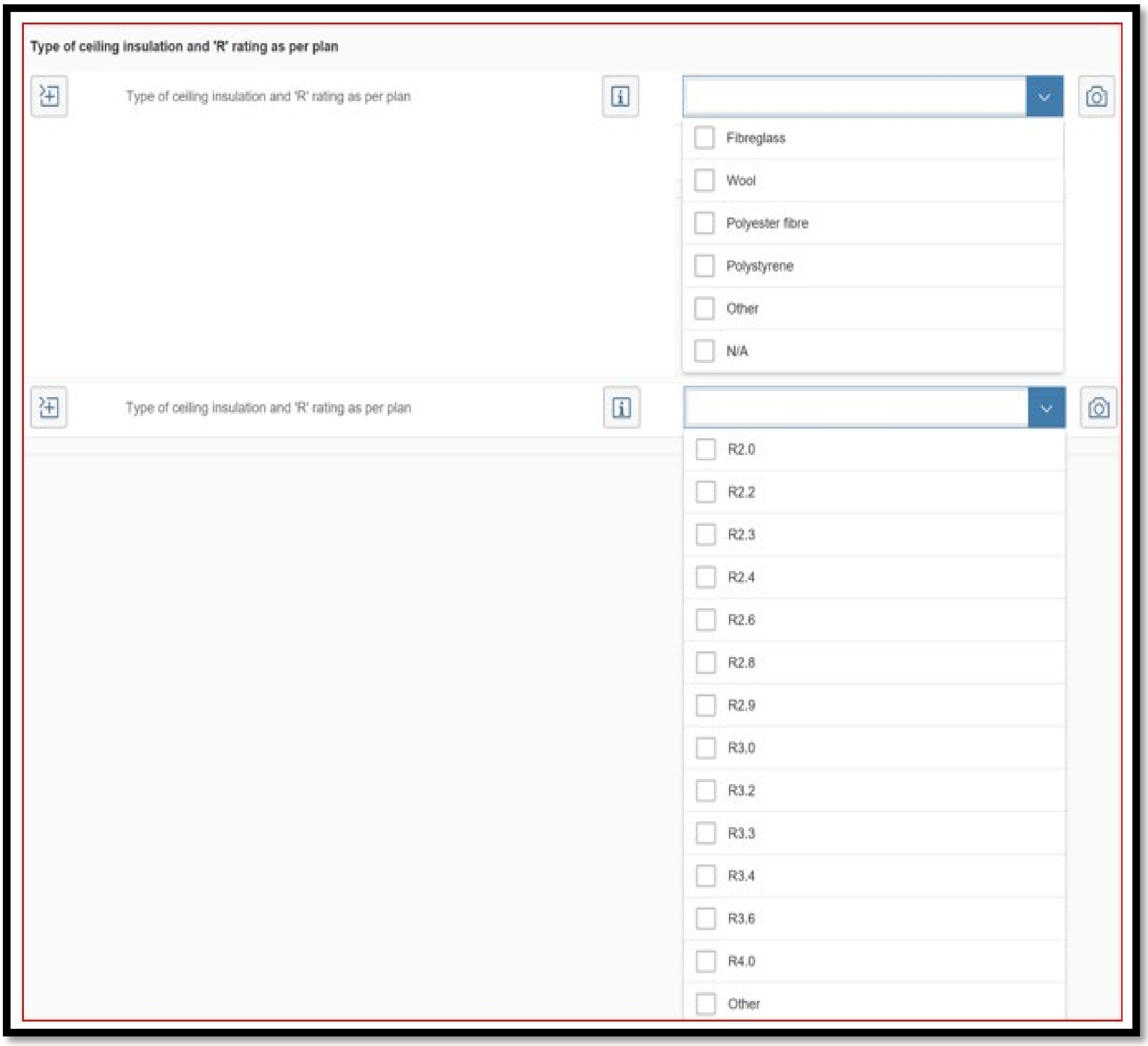


Figure above: Checklist Child line items

Figure above: Checklist Parent line item ‘Type of ceiling insulation and ‘R’ rating as per plan’

Note: When completing this parent line item, consideration must be given to cover all relevant child line items.

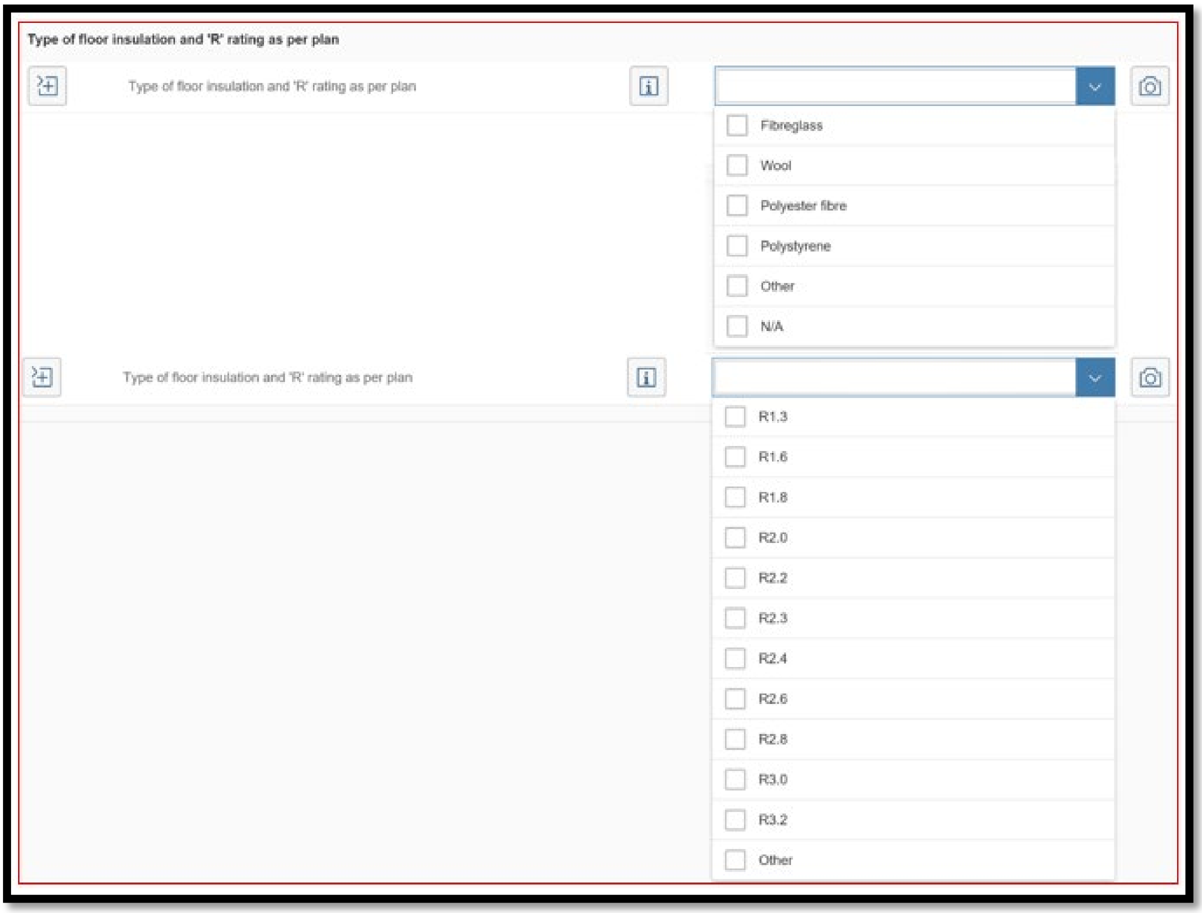


Figure above: Checklist Child line items

Figure above: Checklist line item 'Acoustic insulation as per plan' and 'Insulation used' record product installed

The inspector shall check the approved plans to ensure the correct insulation has been installed, and record the type of insulation and R-value of the insulation installed

Sub-floor

The R-value for reflective insulation is based on the product being correctly installed with the correct airgap, whereas for all other products the R-value is the value of the material itself.

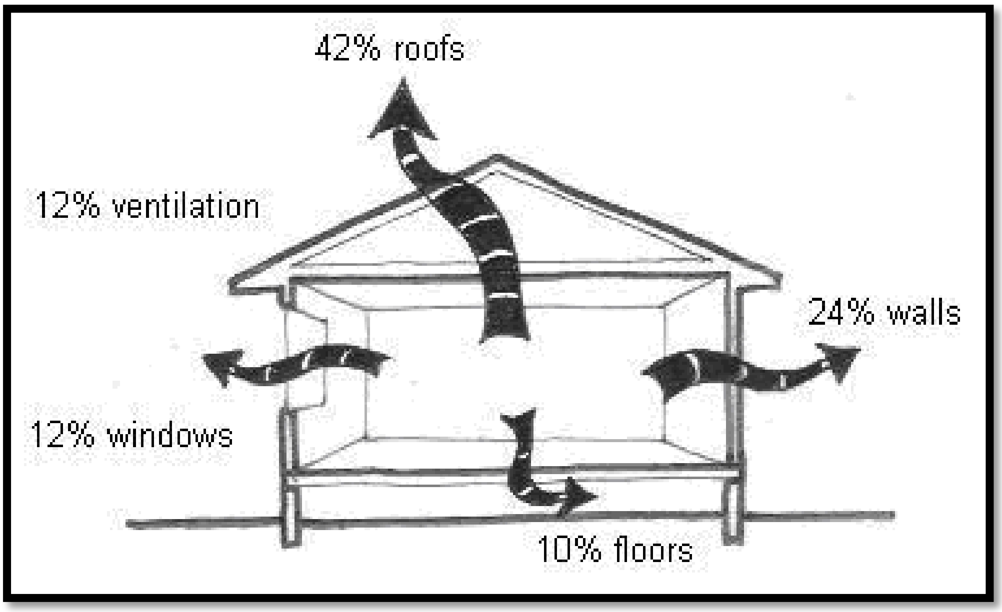
Installing or repairing foil insulation in residential buildings with existing electrical installations is banned under the building Act. It is important to ensure that sisalation does not come in contact with metal pipes and electrical cables; similarly, polystyrene must not make contact with electrical cables and should in this instance be sleeved.

‘Thermashield’ sisalation when installed as per specifications achieves insulation values R1.30 for a single layer, R2.50 for 2 layers, and R3.66 for 3 layers.

Reflective insulation works in the following ways:

- it traps air between the floor and the foil which serves as insulation
- escaping heat is reflected back into the house
- it helps reduce the amount of moisture entering the house through the floor
- minimum R-value in subfloors is R 1.0

Sources of heat loss in an average uninsulated home



Wall insulation

Wall insulation should be cut to fill the cavity. It should not be over packed so that it bulges. The entire space must be filled so that no voids are present.

Figure above: sample of insulation tags

All insulation should be labelled with the following information:

- description of contents
- R-value with the conditions under which the R-value applies, e.g. R2.4 walls
- safety and handling instructions
- installation instructions
- fire safety

Loose fill insulation should state the thickness of fill required to get the stated R-value.

Because loose fill insulation compacts, it will be necessary for a deeper layer to be supplied.

Ceiling insulation

As with wall insulation, labelling must be present. R-values must be recorded, and photos taken to show the installation.

Support

Internal walls in a subfloor space containing insulation must be lined. All external walls (even those in subfloor areas) must have building paper and linings fitted to both sides of the wall. Plaster board is not acceptable as the external lining in a subfloor area.

Wall insulation to a skirt roof must be supported to prevent it from falling out into the ceiling below.

Acoustic insulation

It is important to realise that the testing of an acoustic system is based on all components being installed exactly as described, e.g. if JH Mineral wool insulation is specified and a different brand of insulation is used, then verification must be sort from the manufacturer that the system will still meet the performance requirements specified. Variations may significantly compromise performance. Labelling must be present, R-values recorded, and photos taken to show the installation.

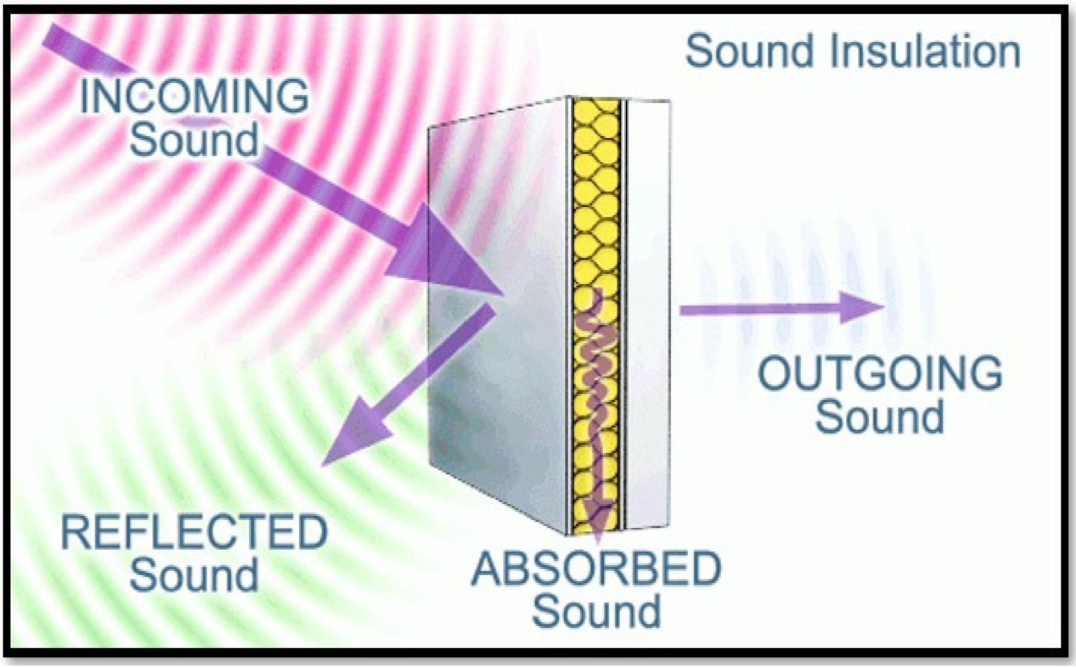


Figure above: detail of noise transference through a wall

Building code clause G6 requiers that habitable spaces are protected from other occupancies using wall and floor and ceiling elements with a laboratory tested performance of STC55 (walls and floors) and IIC 55 (floors only).

Sound transmission class (STC) means a single number rating derived from measured valuse of transmission loss. It provides an estimate of a partition in certain common sound insulation situations.

Impact insulation class (IIC) means a single number rating derived from measured values of normal impact sound pressure levels. This method uses a tapping machine to guage the impact of sound through floor-ceiling assemblies.

The ability of building materials to resist the transmission of sound is dependent on their density, thickness and stiffness. Light and stiff materials have poor sound insulation properties because they allow sound at certain frequencies to transmit easily. Materials of similar thickness and weight can have different sound reduction performance if they have different critical frequencies. For example, laminated glass has a better sound reduction because it reduces the effect of the critical frequency by dampening vibration and reducing the stiffness of the window.

There is no optimum window to wall ratio. From an acoustic point of view the smaller the window the better it is. This is because glazing is the weakest path and thicker glazing or double glazing is more expensive in comparison to other building systems. The newer types of laminated glazing using a PMM interlayer (e.g. Pilkington HUSH Glass) provides about a 3 dBA improvement over similar thickness float glass. A 3 dBA reduction would otherwise require an increase from 6mm to 10mm float glass.

The performance of pre-cast concrete walls more than 150mm thick and solid filled masonry 200mm thick is very sensitive to construction practices, detailing and concrete density. Although these walls can achieve STC 55, the sound attenuation is greatly enhanced when resilient mounts and/or battens are installed on at least one side. These additions can be counter productive unless a minimum cavity of 45mm is created and filled with sound control infill prior to lining. Note that polystyrene is not a suitable infill.

Where separate tenancies adjoin each other, noise is a fundamental consideration. NZBC Clause G6 requires that habitable spaces in household units are protected from other occupancies using wall and floor/ceiling elements with a laboratory tested performance of STC 55 (walls and floors) and IIC 55 (floors only).

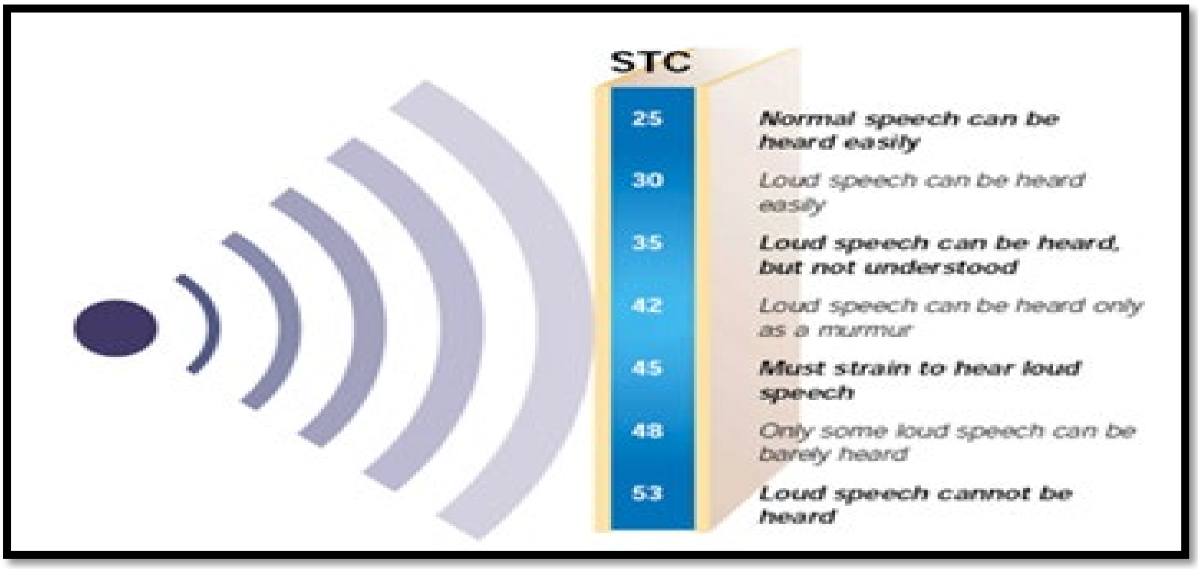


Figure above: sample of STC ratings in dB

STC sound transmission class: How well a building assembly attenuates (reduces) airborne sound. A larger number means more attenuation. STC 55 is the minimum to meet the criteria of NZBC G6.

There are 4 elements to sound attenuation:

- decoupling (separating walls/ceilings so noise will not travel through space)
- damping (stopping the drywall from vibrating using sealant on drywall or using materials that will not vibrate)
- mass (making walls as heavy as possible)
- absorption (filling the void with insulation to absorb the sound, sealants, underlays, etc).

Timber framed walls

Framing generally consists of two frames with a 25-65mm gap, which varies depending on the stud size (70-90mm) used. Note that all but one of the systems specified require 90mm framing to which insulation and lining material is fitted. Studs are generally at 600 c/s maximum and nogs 1350mm centres. In timber-framed walls, stud heights are restricted to NZS3604.

Figure above: sample of resilient clips on rubber grommets to reduce vibration. The clips are designed to carry a channel which the drywall is attached to.

Steel framed walls

If steel framing is used, the recommended stud height is 2.7m unless specific design has been provided. If a Rhondo resilient channel is used the wall height can be increased to 3.6m. GIB® now have non-SED systems up to 4.8m high with 92 x 34mm x 0.75mm steel studs 400mm centres, with a 25mm expansion tolerance at the top of the studs. The inspector will refer to the acoustic system specifications to ensure the correct installation of framing.

Studs must be friction fitted with a minimum 15mm expansion gap at the top of the frame, with no fixings to the top of the channel, R1.8 (75mm) pink batts glass-wool insulation installed between the studs and nogs on one side of the double framing.

It is important to realise that the testing of this system is based on all components being installed exactly as described, e.g. R1.8 pink batts are specified therefore if a different brand of insulation has been used, verification must be sought from the manufacturer (e.g. Winstone Wallboards) that the system will still meet the performance requirements specified. Variations can significantly compromise performance.

Concrete and concrete masonry

The performance of pre-cast concrete walls more than 150mm thick and solid filled masonry 200mm thick is very sensitive to construction practices, detailing and concrete density. Although these walls can achieve STC55 the sound attenuation is greatly enhanced when resilient channel mounts and battens are installed on at least one side. These additions can be counter intuitive unless a minimum cavity of 45mm is created and filled with sound control infill prior to lining. Note that polystyrene is not a suitable infill to achieve sound attenuation.

On floors, carpet and underlay will also reduce noise whereas tiles will increase and transmit noise. It is important the inspector check the acoustic system and floor coverings as specified in the consented plans.

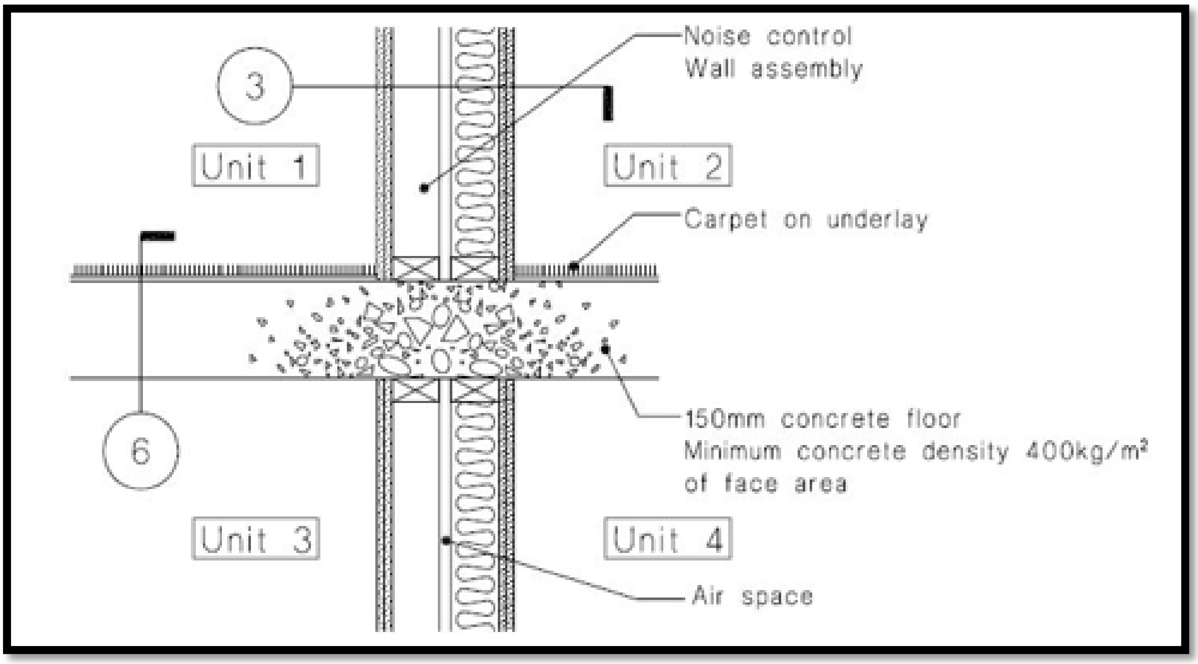


Figure above: sample of acoustic requirements to intertenancies

Fire protection

Figure above: Checklist line item ‘Fire protection scope’

Building Code C/AS2 Definitions: ‘Fire’ is defined as *“The state of combustion during which materials burn producing heat, toxic gases, or smoke or flame or any combination of these.”*

All provisions for passive fire protection must be in place. This includes the correct framing to support fire rated linings, access for fire-rated linings to be installed behind stairs and past ceilings up to the underside of roofing where required, metal flush boxes with intumescent pads installed, fire rated glazing installed and correctly labelled, and all fire seals, wraps, collars, dampers, curtains installed in accordance with the manufacturers specifications and located as per the approved plans.

Fire Resistance Ratings (FRR)

Although commonly referred to as fire rating, the correct term to describe the fire resistance of a building element is FRL (Fire Resistance Level). The FRL is the ability of a building element to withstand a fire under test conditions for a certain period and consists of the three criteria; structural adequacy, integrity, and insulation.

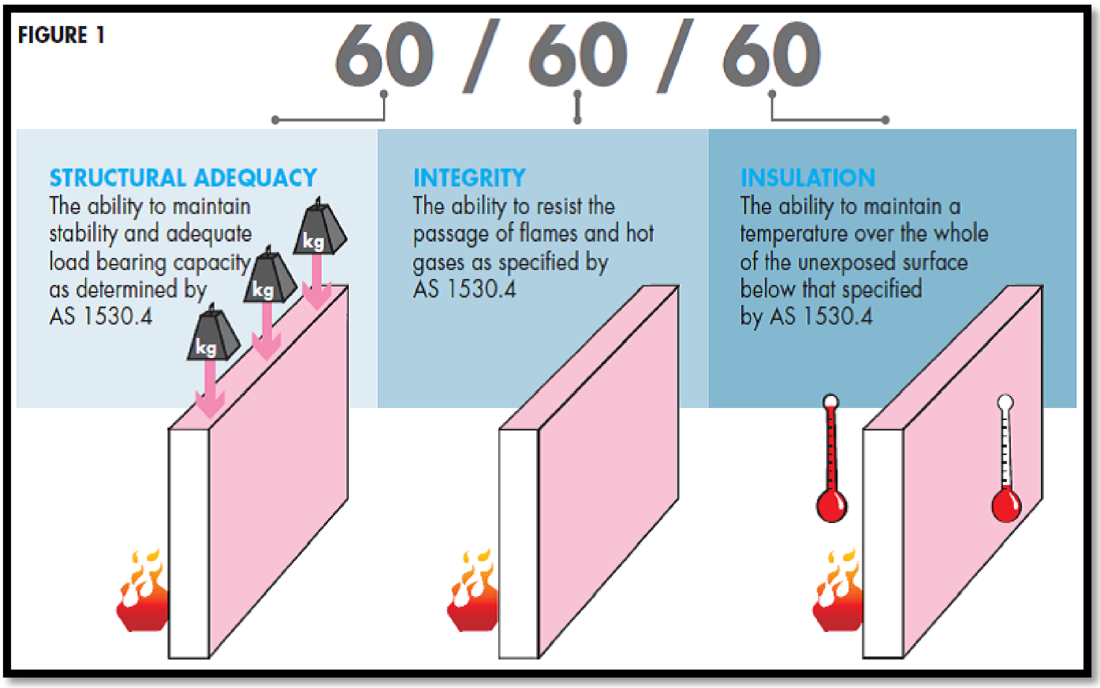


Figure above: sample of FRR definition

The **first two** numbers of the sequence in this series is for **Stability**. Stability is provided by the primary elements within the fire cell and are elements, which are part of or support the structural framing, including columns, beams, floors, and walls.

The **second two** numbers of the sequence in this series are for Integrity. **Integrity** is provided by the secondary elements, e.g. fire separations being internal walls and floors. Integrity is the ability to resist the passage of flames and hot gases.

The **last two numbers** of the sequence in this series is for **Insulation**. Insulation is provided by either the primary or secondary elements and required where the transmission of heat through the element may endanger occupants on the other side or cause fire to spread to other fire cells or adjacent buildings.

FRR are expressed as a series of numbers, e.g. 60/60/60. The values applied to each of the three components of the FRR, depend on the function and location of the building elements to which the FRR applies. In some cases, all three numbers will be the same, in others, the numbers will differ and may even have a value of zero.

An FRR for a wall system generally applies in both directions unless it is a '**one way'** specification. Both the exposed and unexposed linings contribute to the performance of a conventional and symmetrical **two-way** FRR specification. The exposed lining mainly protects the framing and acts as a radiation shield for the unexposed lining. As cavity temperatures rise, the unexposed lining delays insulation failure on the unexposed face of the specimen. Specifications with a **one-way** FRR only protect against fire from the framing side where the protective linings are attached. Cavity temperatures on the unexposed face of the linings can rise to approximately 300°C, but 90mm away the insulation criteria are met. This is why a 90mm cavity is specified with **one-way** systems and even claddings with poor thermal properties, such as thin steel, are permitted. **One-way** specifications also protect timber from char and steel from significant loss of strength, and this is why any timber or steel framing is permitted as long as it has the correct spacing and width for fixing of the linings and meets normal (cold) criteria for strength and serviceability.

An easy way to differentiate between a **one-way** and **two-way** system is to think of a fire starting within **one fire cell** as opposed to a fire starting on one side of an intertenancy wall (**two-way** wall). An internal wall supporting a mezzanine floor will be a **one-way** FRR fire rated wall system to both sides of the wall because the fire is able to access both sides of the wall.

Structural steel members are sometimes located inside the cavity of a GIB® Fire Rated System, such as a column in a wall or beam in a floor/ceiling system. The FRR of a wall or floor/ceiling system applies across the entire element, from the exposed to the unexposed face. Temperatures inside the cavity can rise to a critical level for some steel members and it cannot be automatically assumed that a steel member achieves the structural adequacy rating of the cavity system within which it is contained. For example, a steel post within a two-way fire rated system would need to be encased in another layer of fire rated plasterboard or be intumescent painted to achieve FRR structural stability.

A wall supporting a fire rated floor above requires a structural adequacy rating no less than the FRR of the floor. In this case simply selecting an FRR may not always be appropriate, such as when the wall is located entirely within a fire-cell and is not itself a fire separation. In a standard furnace test for fire resistance, a specimen is commonly exposed from one side only. If a wall located within a fire-cell is potentially exposed to fire from both sides simultaneously, '**universa**l' or '**one way'** lining protection may need to be provided to both sides.

Figure above: Checklist line item ‘Fire lining sheet edge back blocking’

All fire lining sheet edges should be supported by framing. The inspector is to ensure there is solid support top and bottom (top plate and bottom plate), studs are at the max. centres as required by the fire system and will coincide with sheet joins (e.g. 1.2m). Solid blocking will be necessary between trusses, joists, beams, columns, penetrations, etc. Fire rated walls must be completed before ceiling linings / suspended ceilings are erected.

Figure above: Checklist line item ‘Continuous lining support behind stairs, up to roofing, past ceiling etc’

Fire ratings must be continuous, below the flooring down to subfloor finished ground level, behind stairs, past ceilings up to the roof cladding.

Figure above: Checklist line item ‘Electrical flush box intumescent pads installed’

All electrical flush boxes in fire rated walls must be metal (not plastic), and an intumescent pad must be installed in each flush box. Flush boxes and light fittings should not be installed back-to-back on a fire rated inter-tenancy wall.

Note: this does not apply to fire rated wall systems that have a central layer that forms the fire rating, e.g. KOROK® Intertenancy Systems, Resene INTEGRA Lightweight Concrete Intertenancy System, USG Boral IntRwall System, GIB® Barrierline® System to name a few.

An alternative to this is to fire rate the framing cavity before installing the electric flush boxes and wiring.

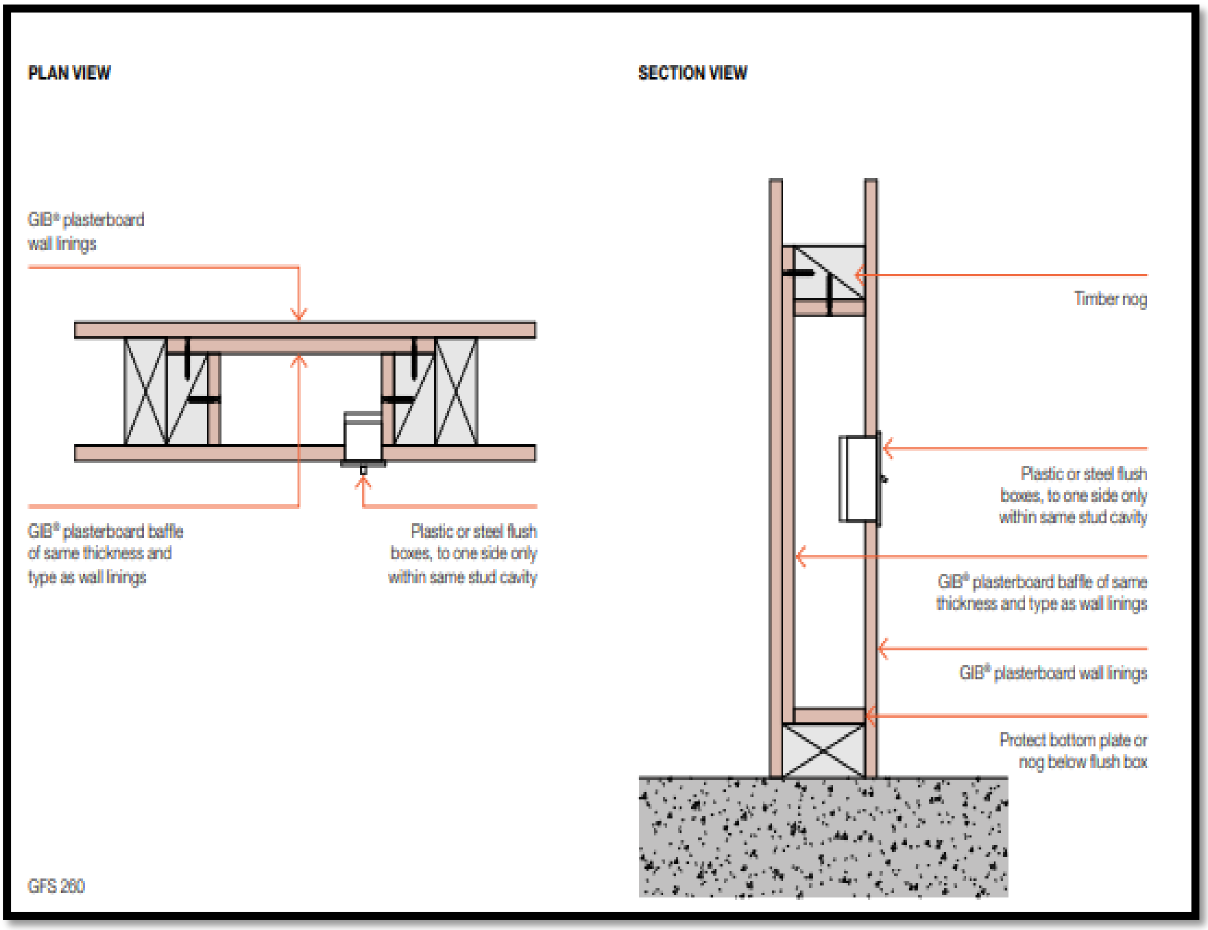


Figure above: Gib® detail for fire rating the wall framing cavity.

Fire glazing

Figure above: Checklist line item 'Fire glazing installed where required'

The inspector is to check that the glazing is fire-rated, ensuring all fire rated glazing is labelled. Refer to fire resistant glazing covered earlier in this module under 'Glazing'.

Fire wraps/seals

Figure above: Checklist Parent line item 'Fire wraps/seals installed (record make and description)'

Note: When completing this parent line item, consideration must be given to cover all relevant child line items.

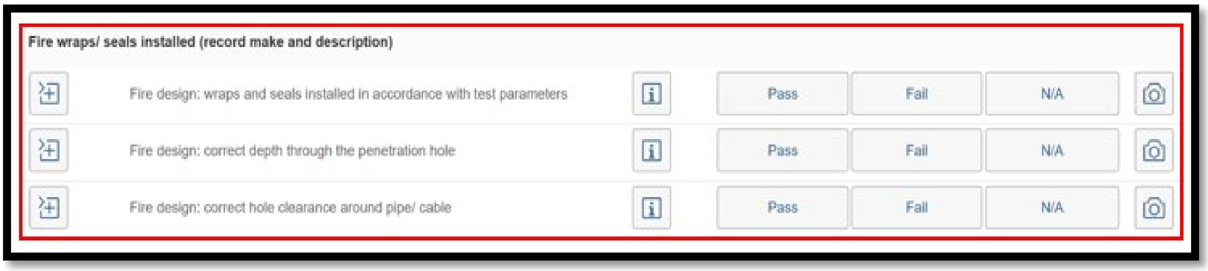


Figure above: Checklist Child line items

All penetrations in the firewall have a fire wrap or seal installed. Because specific products have a unique scope of application, the inspector is to check the wrap/seal is as specified on the consented plan, and installed as per the product specifications, test parameters. Wraps/seals require specific depth and aperture clearance around the penetration which the inspector must check complies with the product installation specifications.

Dampers

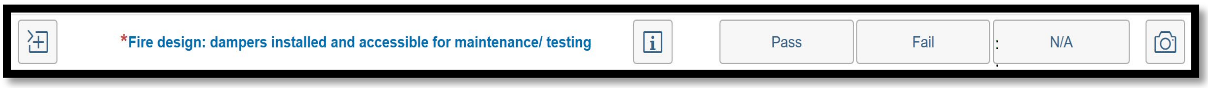


Figure above: Checklist Parent line item 'Fire design: dampers installed & accessible for maintenance/testing.

Note: When completing this parent line item, consideration must be given to cover all relevant child line items.

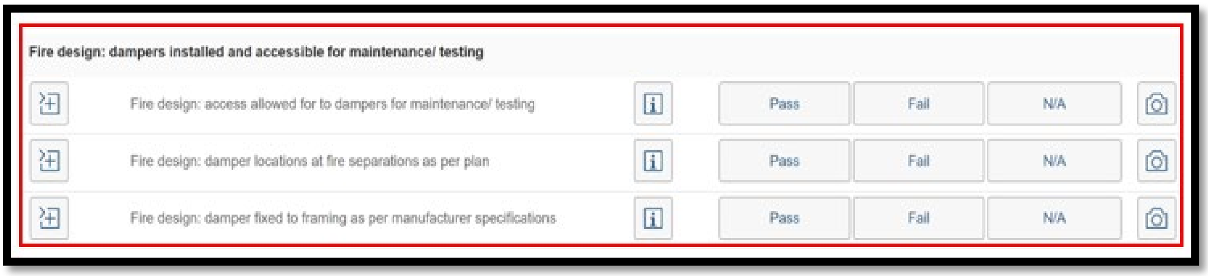


Figure above: Checklist Child line items

Fire dampers are passive fire protection products used in heating, ventilation, and air conditioning (HVAC) ducts to prevent the spread of fire inside the ductwork through fire-resistance rated walls and floors. Fire/smoke dampers are like fire dampers in fire resistance rating and prevent the spread of smoke inside the ducts. When a rise in temperature occurs, the fire damper closes, usually activated by a thermal element which melts at temperatures higher than ambient but low enough to indicate the presence of a fire, allowing springs to close the damper blades. Fire dampers can also close following receipt of an electrical signal from a fire alarm system utilising detector remote from the damper, indicating the sensing of heat or smoke in the building occupied spaces or in the HVAC duct system.

The inspector is to check that dampers are located at fire separations as per plan, fixed to the framing as per the manufacturers specifications and that there is sufficient access for testing and maintenance.

Intumescent fire dampers differ from regular fire dampers in that they have no moving parts. Instead, they expand to many times their normal size upon exposure to elevated temperatures indicative of a fire, forming an incombustible mass which seals its aperture, preventing the spread of fire and hot smoke.

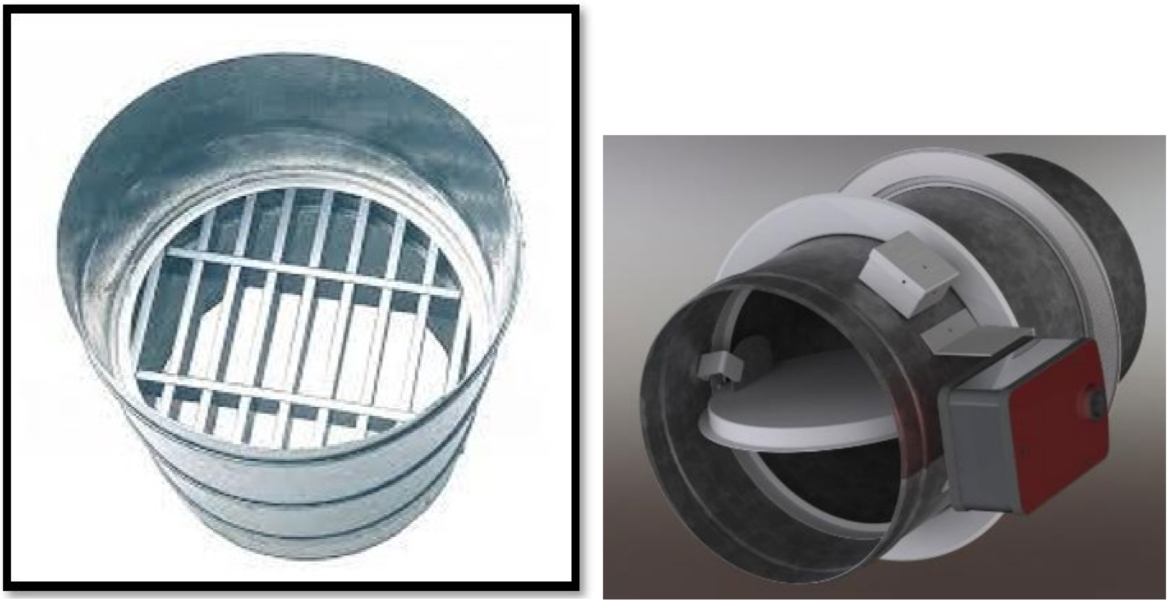


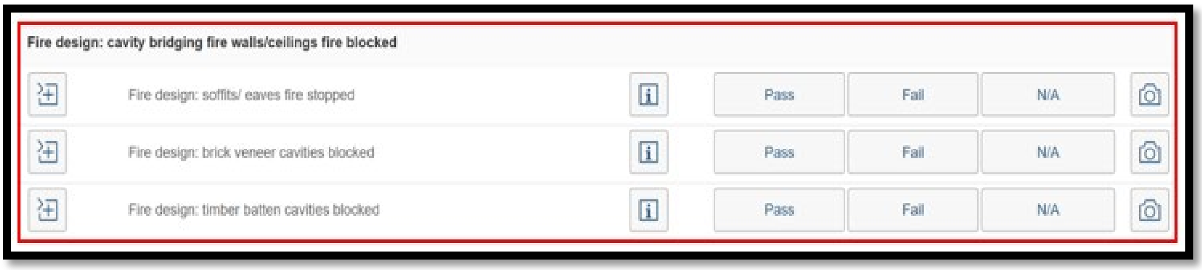
Figure above: sample of dampers - intumescent and mechanical.

Cavity bridging

*Fire design: cavity bridging fire walls/ceilings fire blocked	Pass	Fail	N/A	

Figure above: Checklist Parent line item 'Fire design: cavity bridging fire walls/ceilings fire blocked'

Note: When completing this parent line item, consideration must be given to cover all relevant child line items.



Fire design: cavity bridging fire walls/ceilings fire blocked

Fire design: soffits/ eaves fire stopped	Pass	Fail	N/A
Fire design: brick veneer cavities blocked	Pass	Fail	N/A
Fire design: timber batten cavities blocked	Pass	Fail	N/A

Figure above: Checklist Child line items

Soffits and eaves must be fire stopped if they form part of the fire cell. For dwellings more than 1m from the boundary but where roof eaves extend from an otherwise unrated external wall to within 650mm of the relevant boundary, the external wall up to the roof cladding, or the total eaves construction and the external wall from which they project shall have a fire rating of no less than 30/30/30.

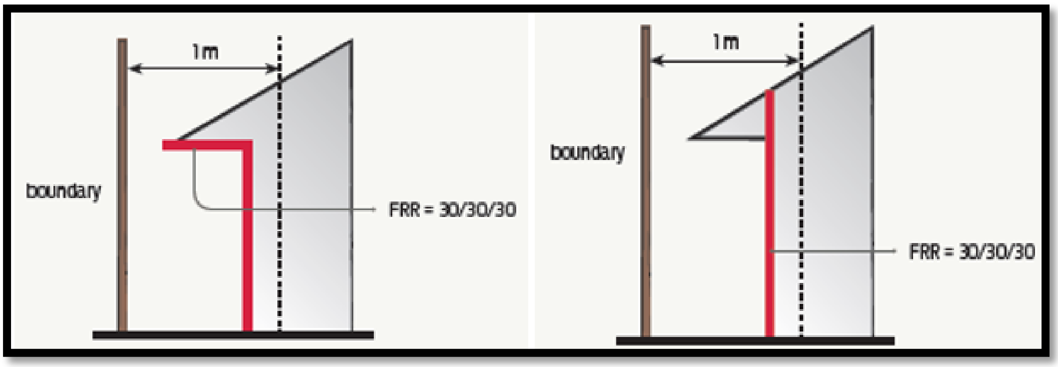


Figure above: sample of fire rating choices to eaves

Continuous vertical channels and cavities within external cladding systems are known to promote upward vertical fire spread. Fire researchers have noted that when flames are confined within a vertical cavity or channel they elongate, leading to flame extension of up to five to ten times the expected unconfined flame lengths. This flame extension effect can support rapid, potentially unseen, fire spread within an external wall cladding system and must be limited. Consideration is needed to ensure that cavity barriers within a façade system located at the junction of fire separations and the external wall assembly have adequate support, can remain in place for the period required, and provide the required level of fire resistance rating.

If the cavity configuration could lead to smoke being conducted into another fire cell in less time than the fire-rated separation provides, then the cavity should have a smoke barrier. This is not simply a matter of inserting something non-combustible into the cavity to form an air seal, as it could interfere with cavity drainage for horizontal joint fire separation.

A flame-proof barrier providing smoke protection between a cavity and the interior is another possible way to deal with multi-unit fire separation. If this is pierced by windows or other penetrations, then a closer similar to the flashing in a movement-control joint would be needed to close off the potential smoke path.

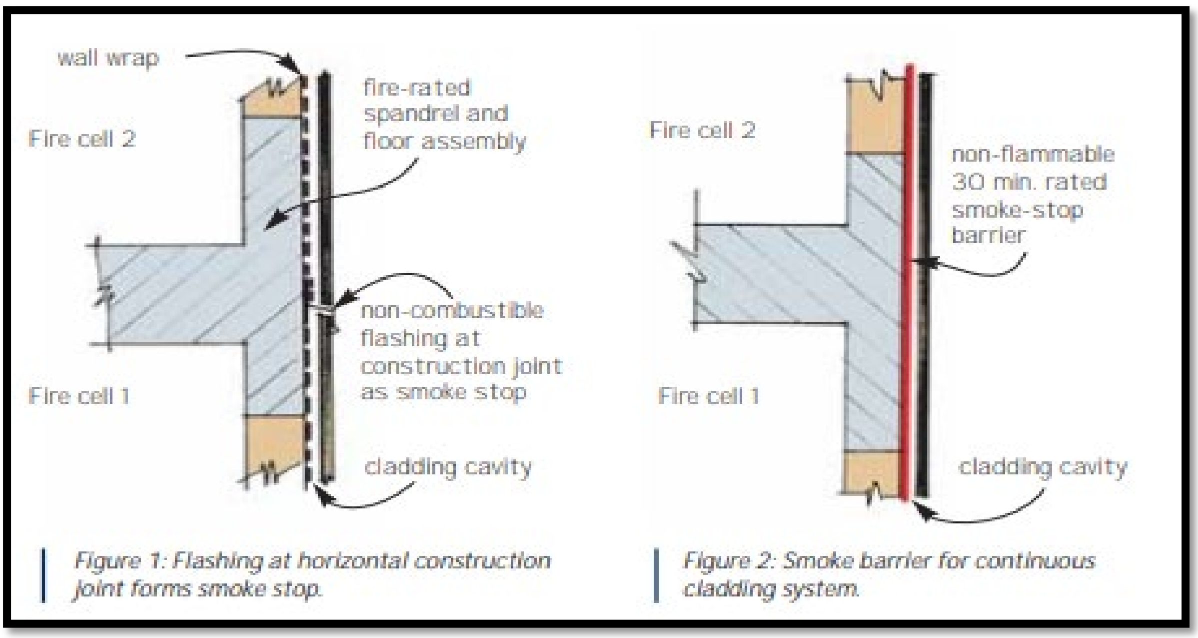


Figure above: detail for smoke barrier/stop in a cavity, sourced from BRANZ Build magazine

Fire curtain

Figure above: Checklist line item ‘Fire curtain installation’

Fire curtains are life safety systems that are designed to arrest the spread of fire in a building. A fire curtain is a specially constructed curtain that descends from the ceiling to block an opening and stop fire and smoke spreading between two areas. In larger structures, several fire curtains are used which divide the building into ‘fire compartments’ when there is a fire.

A fire curtain is similar to a metal roller shutter in that it descends vertically as it un-rolls from a ‘top box’, however because a fire curtain is made of a woven fibre glass material, it is much more flexible and compact.

This means a curtain can be more closely fitted within a space and therefore provides much better compartmentation.

The compact construction of fire curtains makes them an ideal choice for lobbies, hatches and stairwells where there is limited space. When included in the design stage of a building, they can be recessed into walls and ceilings leaving a thin slit as the only indication that the curtain is there.

There are several types of fire curtain:

- Automatic Fire curtains – Most non-static fire curtains are in fact automatic. They are linked to the fire alarm system, so they automatically descend when there is a fire.
- Static Fire Curtains – Also called fixed fire curtains, these curtains are permanently in place and are used to provide compartmentation in open spaces such as warehouses or lofts.
- Insulated Fire Curtains – These curtains provide extra insulation and allow people to pass by much closer to the curtain without being affected by the heat of the fire on the other side.

All fire curtains must be rigorously tested and certified. These standards ensure that the integrity of a curtain will remain for a certain minimum length of time and that they will continue to work in the extreme conditions of a fire. The inspector is to ensure that the curtain details are as per the plan and all documentation is provided as per the consent advice notes.

Fire/smoke doors

Figure above: Checklist line item 'Fire/smoke doors installed'

Fire doors are an integral part of a fire separation and include the doorframe, leaf, glass, intumescent seals, hinges and hardware.

A fire door is a door with a fire-resistant rating used in conjunction with other passive fire protection systems to reduce the spread of fire and smoke between sections of a building or structure. Fire doors are vital when creating safe paths for occupants of the building to escape without harm, NZ Fire Service personnel to conduct their operations within the building, and for the protection of other property in some cases.

The inspector is to check the fire doors are located as per plan, installed in accordance with the manufacturers specification and labelled correctly. Fire sealant with the same FRR is required between the framing and the doorset.

A panel above or to the side of a doorset, which is not contained within the door frame is considered to be part of the wall and is therefore subject to the structural adequacy, integrity, and insulation requirements set out in the compliance documents of NZBC.

The fire-resistant doorset shall be self-closing or automatic. Automatic doorsets shall revert to self-closing on operation of a sensing device, or on the loss of power to the electromagnetic hold-open device.

The fire-door shall be constructed with solid core leaves and shall have a leaf thickness of no less than 35mm. The door frames shall be constructed of timber and the jambs no less than 30mm thick.

Glazing in fire doors shall be fire resisting glazing having the same integrity value as the door. If the door requires an insulation value, an uninsulated vision panel may be used without downgrading the insulation value of the door. Any vision panel cut-outs are no less than 150mm from the leaf edges.

The maximum average clearances (excluding pre-easing) are 3mm leaf to frame, 5mm leaf to leaf, and leaf to top of any floor covering 10mm.

Fire-resistant doorset
To NZS 4520:2010
FRR –/xx/yy
MANUFACTURED BY (company) LTD
DOORSET NO. 12345
YEAR OF MANUFACTURE – 2012

All fire doors shall have tags with the following information:

- The number of the standard
- Name of the manufacturer
- ID number of the individual doorset as recorded in the manufacturer's register
- FRR of the doorset in minutes
- Date of manufacture

Fire design: structural steel intumescent coating

Figure above: Checklist line item 'Fire design: structural steel intumescent coating installed and adequate clearance around'

Intumescent is a substance that when exposed to heat, increases in volume and decreases in density. Application of intumescent paint layers helps fireproof structural steel and can be used externally or internally. Intumescent coatings are generally available as water-based or solvent based variations.

Steel intumescent coatings have a fire resistance rating of 30 to 120 minutes and they usually consist of three layers:

- Primer
- Basecoat (the reactive component)
- Sealer coat

Under the intense pressure and heat from a fire, most intumescent paints work by producing a foam-like substance, from the chemicals in it reacting and releasing a vapour.

Upon carbonisation, the foam will solidify to a black material (a char), which insulates and protects the integrity of the steel, cast iron, or wood surface. As the intumescent paint expands (sometimes between 50x and 100x the original coating's thickness) in the event of a fire, protecting the surface from heat, the surface is not burning, but simply undergoing a catalytic chemical reaction.

Unprotected steelwork can reach temperatures of 550°C in a fire, where it then can lose its load bearing capacity and collapse. Building regulations and legislation demand fire protection to upgrade the fire resistance of buildings.

Intumescent paint and coatings can be applied by brush, roller or spray in a series of coatings which build up to the thickness required to correspond with the level of protection mandated by the Building Code. Intumescent installation should come with a datasheet, outlining application methods, drying time and layer specifications before the top, pigmented to colour, layer is applied.

Thin film intumescent coatings usually require a primer to be applied to the steel first and sealer topcoat to finish the system to offer between 30 and 90-minutes fire resistance. 120 fire resisting intumescent coatings are available with some manufacturers.

Thick film intumescent coatings are frequently epoxy based. They have a higher dry film thickness and were originally developed for use with hydrocarbon fires. Thick films do not expand as much as thin films in the event of a fire. Thick film intumescent coatings may be used on external steel in high rise buildings, office towers and exposed marine/oil refinery environments.

Inspectors should ask for the quality assurance process which is used on-site to confirm the coating thicknesses have been met. Applicators are required to keep records of their testing results and provide these in a report to the inspector when requested at an audit inspection or at CCC stage. In high risk or complex projects, an independent third party may be required to undertake the thickness testing. These requirements including the provision of producer statements should be outlined on the Building Consent advice notes or agreed to upfront at the pre-construction meeting.

Preline plumbing

Figure above: Checklist line item 'Preline plumbing scope'

Figure above: Checklist line item 'Plumber details recorded'

There are various classes of plumbing licences, but all plumbing work must be signed off by a **certified plumber**.

Certified plumber class is the top-level registration and licence. Certifiers have demonstrated they possess the advanced competencies required to test and certify their own work and be responsible for the work of those they supervise. They are the only plumbers that can verify work for official purposes (sign off compliance documents for local councils).

Tradesman is a qualified plumber but must be supervised by a **Certified** plumber who is ultimately responsible for ensuring the work is done competently. They must work under the supervision of a **Certifier** and under the direction of their **Certifier** may physically supervise**,** as a '**nominated person'**, sanitary plumbing, gasfitting and drainlaying work undertaken by another currently authorised Tradesman, Provisional licence holder, Trainee Limited Certificate, or Exemption Under Supervision for the relevant trade.

Journeyman class is for plumbers, gasfitters and drainlayers who have not passed the Boards relevant licencing exam but have completed the National Cert or Trade Practice Cert qualification.

Provisional licence class is issued to overseas-qualified people who have been approved for pre-registration and are issued for a maximum 12 months while they wait to sit the tradesman registration exam or do an advanced proficiency assessment.

Trainee Limited Certificate is a person who is enrolled with a training provider to complete the NZ certificate in plumbing, gasfitting and drainlaying. During the first 12 months the limited certificate trainee is required to work in the direct presence of a supervisor or 'nominated person'.

Exemption Under Supervision (EUS) class is where during the first 24 months of an EUS the practitioner is required to work in the direct presence of a supervisor or 'nominated person'.

Water supply

Figure above: Checklist line item ‘Preline Pipework Test result and method’

Figure above: Checklist Parent line item ‘Preline water supply pipe material as per plan and installed correctly’

Note: When completing this parent line item, consideration must be given to cover all relevant child line items.

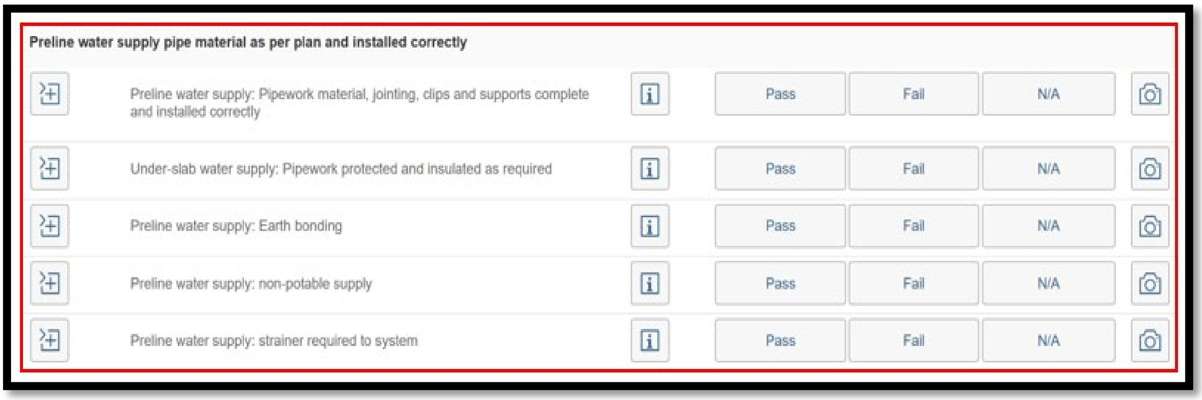


Figure above: Checklist Child line items

Figure above: Checklist line item ‘Preline water supply pipe material Type (select one)’

A plumbing system is defined as pipes, joints and fittings, laid above ground and used for the conveyance of foul water to the foul water drain and include vent pipes.

Always check and confirm the plumber’s registration details and record this information on the inspection records.

All pipe work must be on test at the pre-line inspection. Pipe work may be tested as follows:

- By pressurising the pipework to 1500kPa for a period of not less than 15 minutes for the cold-water supply and for a period of not less than 30 minutes for the hot water supply and checking to see that there are no leaks (NZBC G12/AS1 7.5).

- By pressurising the UPVC cold water pipework to 1.5 times the maximum working pressure for a period of not less than 15 minutes and checking to see that there are no leaks (NZBC G12/AS1 NZS7643 9.3.3.2 Procedure A).
- By pressurising the pipework to 1500kPa for a period of not less than 5 minutes and checking to see that there are no leaks (NZBC G1/VM1, AS/NZS 3500.1 and AS/NZS 3500.4).

Where the water supply pipework is not on test a producer statement construction (PS3) will be provided by the plumber identifying and verifying the test method, at the time of the next inspection. In addition, the manufacturers of Polypropylene, Fusio and Aqua-therm (polypropylene testing certificate) each require testing certificates (issued by a certification body to Plumbers) be sent back to Germany to validate the warranty.

All pipes must be adequately protected. Where copper pipes are installed, silicone should be squirted around the pipe to hold it in place and stop rattling and hammer occurring. In firewalls, collars and sleeves must be fitted, along with intumescent seals.

Pipes must be clipped and supported to either roof or subfloor framing as applicable. Centres are determined by the size of the pipe.

For under slab water supply all pipes in contact with concrete must be sleeved in a larger pipe to protect the pipe from damage.

If the layout or materials have changed and do not affect compliance, obtain as-built drawings and make sure the owner signs a letter of acknowledgement for the change. If additional fittings, such as a new basin, shower or toilet have been installed a formal amendment will be required. Generally, this will only be required if major changes are evident. All changes should be recorded in inspection records.

Check for any pipe penetrations through building wraps and ensure these are fitted with a support block and air-seal. Under no circumstances are pipes to be installed in cavities.

If water storage heaters are in the ceiling space the maximum capacity is 300 litres. The water storage heater must be supported on a framed floor and be seated within 300mm to centre of a load-bearing wall and requires a minimum of 350mm clearance to the roof above. The floor must be a minimum of 1200mm square and 20mm thick and be nailed at 300mm centres to all edges. A safe tray must be fitted under the unit and seismic restraints are required.

Equipotential bonding

Equipotential bonding is required in accordance with G9 Electrical, New Zealand Building Code where all the following conditions are likely to exist:

- electricity is provided within a building
- the water supply pipe is metallic
- building users can make contact with exposed parts of metal water supply pipe, or any metallic sanitary fixtures connected to it
- the metal pipe is in contact with the ground and forms a continuous metallic link from the ground to those parts of the pipe exposed to building user

Earth bonding conductors must be:

- made of copper and have a cross-sectional area no less than 4.0 mm^2
- sheathed with insulating material coloured green

- fixed at intervals of no greater than 300 mm with aluminium cable fixings

Non-potable water

Non-potable water is water that is not of drinking quality but may still be used for many other systems from roof water catchment, to supply water to WCs, laundry, and hose taps. Non-potable water supply must be clearly identified with lilac coloured piping. The non-potable water supply is protected from the main water supply with backflow prevention, and non-potable signage as required.

If water is to be used for sanitary plumbing system, then a primary screening (leaf catcher) and a first flush device is required and depending on final use may also require additional filtration.

The inspector will check the plans. IDT details in the inspection schedule in the form 5 advice notes and the stormwater report, for details of the retention tank and pump system to be used to supply water to the specified fixtures.

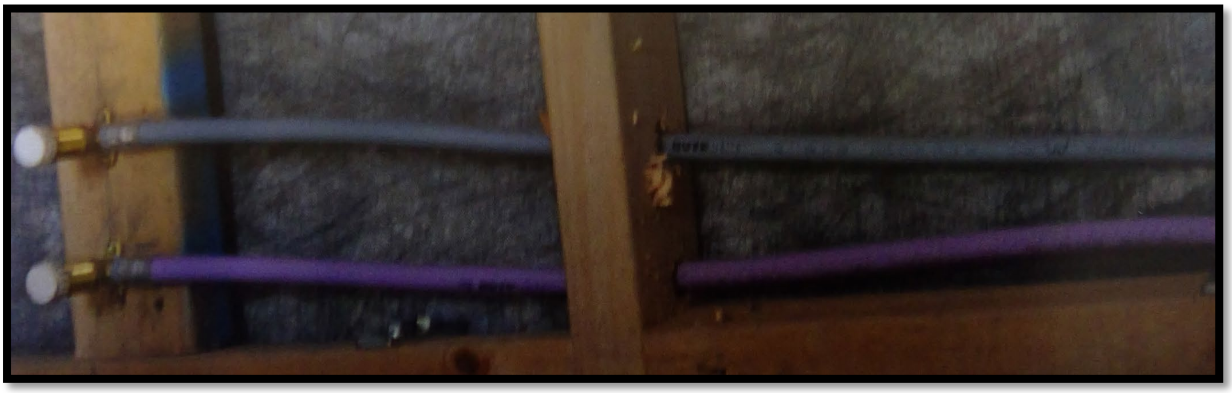
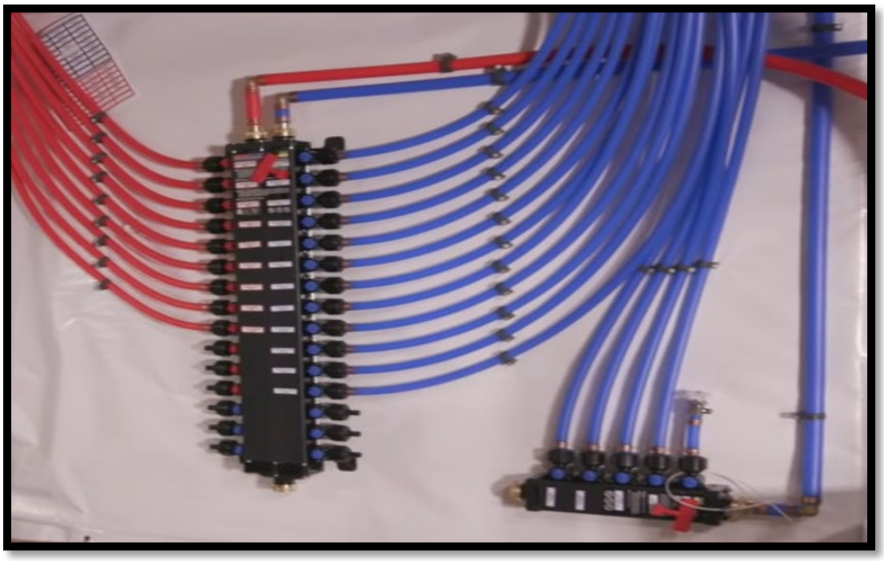


Figure above: example of non-potable water supply pipe lilac colour

Manifold system



A manifold system differs from a traditional reticulated system in that instead of a 'main trunk and branch' involving 'dead legs', the main supply (hot or cold) is connected to a manifold and multiple outlet. Each outlet feeds an individual fixture so uses a much smaller pipe (as small as 10mm diameter) with minimal pressure losses and water wastage.

Figure above: example of a manifold system

Ring main

A **ring main** is a system where the water is ciculated through a continuous (ring) pipe either pumped in one direction or occasionally allowing water to be fed from both directions. Ring mains vast increase the capacity of the system while at the same time greatly reducing pressure losses which occur with conventional systems.

Backflow prevention

Figure above: Checklist line item ‘Back flow prevention-type / make / drain available’

Backflow is the unplanned reversal of flow of water or mixtures of water and contaminants into the water supply system. Backflow protection shall be provided where it is possible for water or contaminants to backflow into the potable water supply system. This can be caused by a drop-in pressure in the mains (back-siphonage) or a backpressure situation. Back-siphonage is the reversal of normal flow in a water system caused by a negative pressure (vacuum or partial vacuum) in the supply pipes.

Back-siphonage can be created when there is a drop in the pressure in the water supply due to firefighting nearby, repairs or breaks in the mains. Liquid or gas is then sucked in the opposite direction to the normal flow. This means that the liquid or contaminants are drawn into the water supply pipe rather than water flowing out.

Backpressure is the reversal of normal flow in a water system caused when the downstream pressure increases above the pressure in the supply pipes. Backpressure is created whenever the downstream pressure exceeds the pressure in the supply pipes. This is possible in installations such as heating systems, elevated tanks and pressure producing systems and may create a 'venturi effect' in private plumbing lines.

A backpressure situation can also be caused by incorrect hydraulic pumping installations, for example a booster pump on a riser main. As the water tends to flow in the direction of least resistance, this means that liquid or gas contaminants can flow into the drinking water supply.

Backflow devices are usually installed as part of an appliance. Backflow devices are required on coffee makers, hair washing basins, dentists’ chairs, sterilisers, fire sprinklers systems, irrigation systems, photography equipment, swimming pools, etc.

A cross connection is when a pipe containing drinking water is allowed to be connected to a line that contains a contaminant. Some examples of this are a fire sprinkler line connected to a water supply pipe, a hose connected to a sink tap with the end of the hose submerged in a tub full of detergent, or water supply pipes connected to bottom fed tanks or boilers.

The ordinary garden hose is the most common offender as it is connected to the drinking water supply and is often used in a variety of situations that could potentially allow contaminants to enter the supply. These types of incidents are not restricted to residential use, but also apply within commercial and industrial environments. A garden tap allows a hose to be easily attached to the drinking water supply for use in a variety of outdoor situations. However, if no backflow prevention device is fitted contaminants can enter the drinking water supply.

Examples of how this can happen include:

- leaving the hose submerged in a swimming pool

- leaving the hose on the ground in the vicinity of fertilisers, cess pools and other garden chemicals
- attaching chemical sprayers to the hose to kill weeds

In each of these situations harmful contaminants could enter the drinking water supply, compromising its integrity and potentially endangering lives.

Backflow protection shall be determined by identifying the individual cross connection hazard(s) and backflow protection required. Water from each hazard shall be regarded as non-potable until an appropriate backflow protection is installed.

The water supply system shall be installed so that there is no likelihood of cross connection between:

- A potable water supply system and a non-potable water supply system
- A potable water supply system connected to a water main, and any water from another source including a private water supply
- A potable water supply system and any bathing facilities including swimming, spa or paddling pools
- A potable water supply system and pipes, fixtures or equipment (including boilers and pumps) containing chemicals, liquids, gases or other non-potable substances

Cross connection hazard has three categories: high, medium and low.

High hazard is any condition, device or practice which, in connection with the potable water supply system, has the potential to cause death. High hazard may include but not necessarily be limited to:

- Autoclaves and sterilisers
- Systems containing chemicals such as anti-freeze, anti-corrosion, biocides, or fungicides
- Beauty salon and hairdresser's sinks
- Boiler, chiller and cooling tower make-up water
- Car and factory washing facilities
- Chemical dispensers
- Chemical injectors
- Chlorinators
- Dental equipment
- Direct heat exchangers
- Fire sprinkler systems and fire hydrant systems that use toxic or hazardous water

Medium hazard is any condition, device or practice which, in connection with the potable water supply system, has the potential to injure or endanger health. Medium hazard may include but not necessarily be limited to:

- Appliances, vehicles or equipment
- Auxiliary water supplies such as pumped and non-pumped fire sprinkler secondary water
- Deionised water, reverse osmosis units and equipment cooling without chemicals
- Fire sprinkler systems and building hydrant systems
- Hose taps and fire hose reels associated with Medium hazard
- Irrigation systems with underground controllers
- Irrigation without chemicals
- Livestock water supply without added chemicals
- Untreated water storage tanks
- Water and steam cleaning

- Water for equipment cooling
- Drink dispensers with carbonators
- Swimming pools, spas and fountains

Note: The examples given are not an exhaustive list. Where there is doubt comparison must be made to the hazard definitions.

Low hazard is any condition, device, or practice which, in connection with the potable water supply system, would constitute a nuisance, by colour, odour or taste, but not injure or endanger health. Backflow prevention shall be achieved by an **air gap** or **backflow prevention device.**

An **air gap** shall be an unobstructed distance between the lowest opening of a water supply outlet and the highest level of the overflow water. The air gap separation shall be the greater of 25mm or twice the supply pipe diameter. To ensure the air gap distance is maintained the overflow pipe discharge flow rate shall be no less than the inlet pipe flow rate.

Backflow prevention devices and **air gaps** shall be located as near as practicable to the potential source of contamination, and in an accessible position for maintenance and testing to AS2845.3 or NZ backflow testing standard.

Backflow protection devices shall be manufactured as reduced pressure zone devices, double check valve devices, pressure type vacuum breakers, or atmospheric vacuum breakers.

Refer to G12/AS1 for general installation requirements.

Table 2: Selection of Backflow Protection
Paragraph 3.4.5

Type of backflow protection	CROSS CONNECTION HAZARD					
	HIGH		MEDIUM		LOW	
	back-pressure	back-siphonage	back-pressure	back-siphonage	back-pressure	back-siphonage
Air gap (see **Note 1**)	✓	✓	✓	✓	✓	✓
Reduced pressure zone device	✓	✓	✓	✓	✓	✓
Double *check valve* assembly (see **Note 2**)			✓	✓	✓	✓
Pressure type vacuum breaker (see **Note 3**)		✓		✓		✓
Atmospheric vacuum breaker (see **Note 4**)		✓		✓		✓

Note:

1. *Air gaps* must not be installed in a *toxic environment.*
2. Double *check valves* can be installed in a medium and low hazard *toxic environment.*
3. Pressure type vacuum breakers are designed to vent at 7 kPa or less. However, they require a significantly higher pressure to reseat and must be installed only in systems which provide pressures sufficient to ensure full closing of the valve.
4. Hose outlet vacuum breakers are a specific type of atmospheric vacuum breaker.

Figure above: Backflow prevention selection from G12/AS1 Table 2.

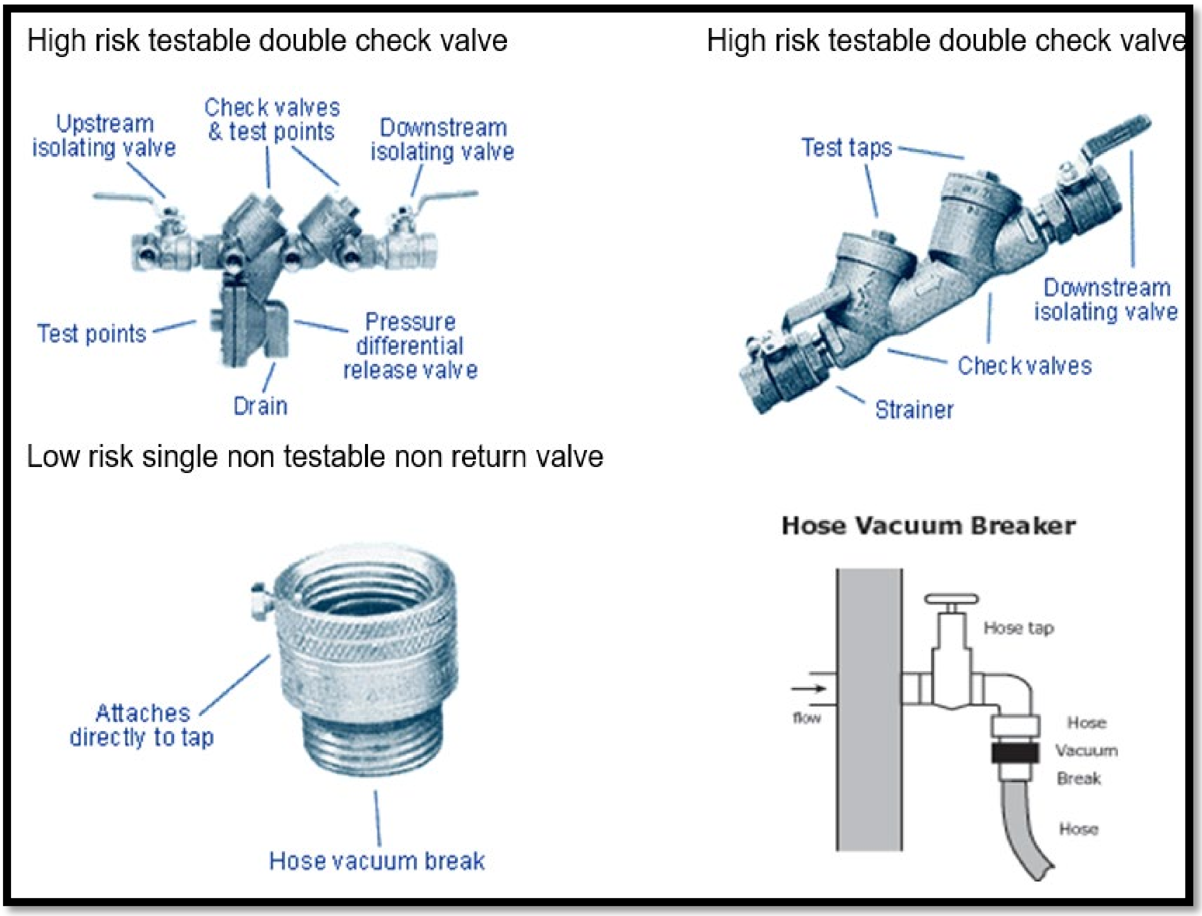


Figure above: sample of backflow prevention devices

Hose vacuum breakers

Hose vacuum breakers are small devices fitted downstream from a hose tap in order to prevent back-siphonage and backpressure. They admit air to the water supply system when subjected to back-siphonage. Under backpressure they allow any flow to discharge from the water supply system. Hose vacuum breakers should only be used for low hazard applications such as domestic hose taps used for irrigation or for drink dispensers.

Atmospheric vacuum breakers (AVB)

Atmospheric vacuum breakers have specific height and location requirements and must have an unobstructed outlet. They have a high hazard rating, but only against back-siphonage. They are non-testable but should be inspected biennially.

Pressure vacuum breakers (PVB)

Pressure vacuum breakers have specific height and location requirements. They have a high hazard rating, but only against back-siphonage and must be tested annually by an Independent Qualified Person (IQP).

Double check valves (DCV)

Double check valves have a medium hazard rating for both backpressure and back-siphonage situations. They must be factory-made single body devices with fitted test ports. They require annual testing by an IQP.

Double check valves consist of two independently acting force locked check valves, sufficient test points and an isolating valve on either side of the assembly. These devices can be used for low and medium hazard applications. They cannot be used for high hazard installations where toxic and highly hazardous substances are used, or in drainage systems or boilers.

Reduced pressure zone valves (RPZ)

RPZ valves are similar to double check valves but incorporate a pressure differential relief valve. This valve allows any flow to discharge to the atmosphere if the pressure drop between the check valves is 14kpa or less. These devices are available for all types of hazards but are the only devices suitable for high hazard areas including shipping water supply (for example at the Ports of Auckland), sewage pumping and treatment facilities, photo processing laboratories and hospitals.

Sprinkler water supply

Figure above: Checklist Parent line item ‘Sprinkler supply as per design’

Note: When completing this parent line item, consideration must be given to cover all relevant child line items.

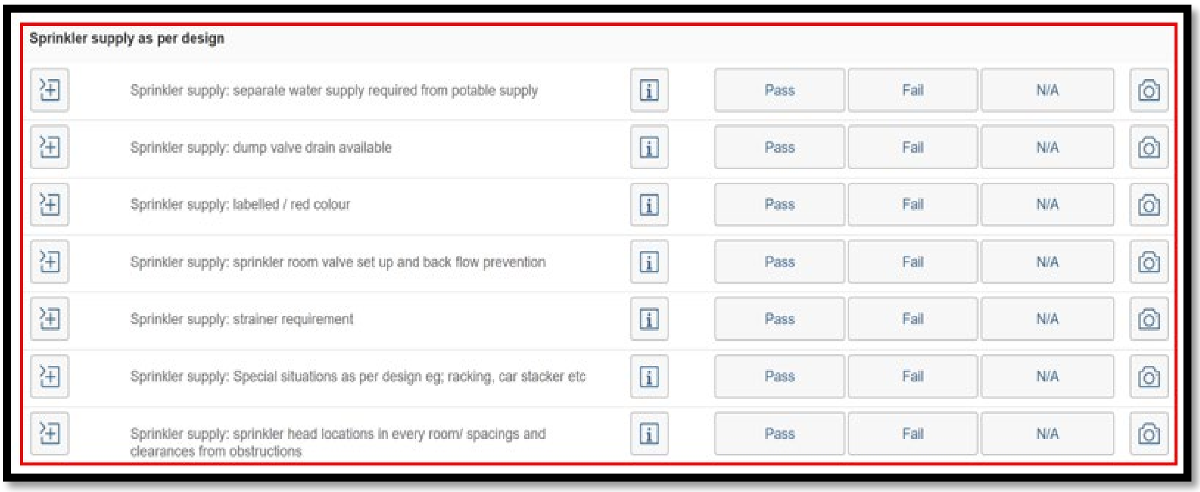


Figure above: Checklist Child line items

Domestic sprinklers

Annually, there are approximately 6000 domestic fires in New Zealand, with an average of 23 deaths each year. Statistics collected by FENZ show that close to 75% of domestic fires start in the kitchen, lounge or bedroom. The most frequent area of fire origin is the kitchen, however the most frequent area of origin for fires which cause fatalities, is the bedroom.

Sprinklers save lives. Since 1996 only six fire related deaths have occurred in New Zealand where sprinklers were installed, and in each case the victims were in intimate contact with the fire. In New Zealand automatic fire sprinklers are better than 99% effective (the most effective fire performance record of any systems in the world).

Surprisingly, the cost of sprinkler protection is less than the cost of floor coverings for the life of a building.

Their operation is conceptually simple. A fire starts somewhere in the protected building causing the sprinkler heads immediately above the fire to operate. Water is discharged from the operating sprinkler heads controlling the fire.

Not every sprinkler head operates. In 90% of fires, where the fire breaks out in one room (e.g. a bedroom or kitchen), then only one sprinkler head will be activated, however in more serious situations, additional heads will be activated. For this reason, a larger diameter water supply pipe will be necessary. For this to be achieved a 25mm supply pipe together with a backflow prevention device is required to be installed at the point of water supply and a 20mm pipe installed for the system.

A building consent is required for the installation of any new plumbing work including the installation of a domestic sprinkler system. A combination fire sprinkler system means one system of pipe work, which includes fire sprinklers and provides a single water supply for **both** domestic potable water and fire protection.

The implications of this are that:

- all pipes must be suitable for potable water
- the water and flow conditions in the pipes must not be prone to contamination (i.e. water must not sit in pipes for long periods of time)
  - a back-flow device must be fitted
  - 25mm supply pipe and 20mm pipe work for the system
- the system must comply with the NZBC requirements for Water Supplies, Clause G12

The design of the system must be in accordance with either NZS 4517 or the BRANZ Domestic Sprinkler Design. Sprinklers should be designed to ensure that a growing fire can be controlled before it develops to a point at which lives are endangered and serious damage is done to the property.

Before code compliance certificate can be issued, test results identifying the flow rate must be provided. This test may be witnessed by the inspector, alternatively a producer statement construction (PS3) may be accepted by a suitably qualified person. Sprinklers must be tested to 1500kPa for at least 15 minutes.

Commercial sprinklers

Since the first sprinklers were introduced to NZ in the late 1880's, approved sprinklers have achieved their fire control function in better than 99.5% of the fires in which they have operated.

Each closed-head sprinkler is held closed by either a heat-sensitive glass bulb or a two-part metal link held together with fusible alloy. The glass bulb or link applies pressure to a pipe cap which acts as a plug which prevents water from flowing until the ambient temperature around the sprinkler reaches the design activation temperature of the individual sprinkler head. In a standard wet-pipe sprinkler system, each sprinkler activates independently when the predetermined heat level is reached. Thus, only sprinklers near the fire will operate, normally just one or two. This maximizes water pressure over the point of fire origin and minimizes water damage to the building.

A sprinkler activation will do less water damage than a fire department hose stream, which provide approximately 900 litres/min. A typical sprinkler used for industrial manufacturing occupancies discharge about 75-150 litres/min. However, a typical Early Suppression Fast Response (ESFR) sprinkler at a pressure of 50 psi (340 kPa) will discharge approximately 380 litres per minute. In addition, a sprinkler will usually activate within one to four minutes of the fire's start, whereas it typically takes at least five minutes for a fire department to register an alarm and drive to the fire site, and an additional ten minutes to set up equipment and apply hose streams to the fire. This additional time can result in a much larger fire, requiring much more water to extinguish.

Sprinkler systems are intended to either control the fire or to suppress the fire. Control mode sprinklers are intended to control the heat release rate of the fire to prevent building structure collapse, and pre-wet the surrounding combustibles to prevent fire spread. The fire is not extinguished until the burning combustibles are exhausted or manual extinguishment is affected by firefighters. Suppression mode sprinklers (formerly known as Early Suppression Fast

Response sprinklers) are intended to result in a severe sudden reduction of the heat release rate of the fire, followed quickly by complete extinguishment, prior to manual intervention.

Most sprinkler systems installed today are designed using an area and density approach. First the building use and building contents are analysed to determine the level of fire hazard. The design area is a theoretical area of the building representing the worst-case area where a fire could burn.

The design density is a measurement of how much water per square metre of floor area should be applied to the design area.

After the design area and density have been determined, calculations are performed to prove that the system can deliver the required amount of water over the required design area. These calculations account for all the pressure that is lost or gained between the water supply source and the sprinklers that would operate in the design area. This includes pressure losses due to friction inside the piping and losses or gains due to elevational differences between the source and the discharging sprinklers.

For all sprinkler systems, pipework, gauges, switches, valves shall be labelled. Every valve which controls the water supply to the sprinkler system shall be labelled to indicate the direction of closing and be affixed with a label bearing the embossed or engraved words '**FIRE SPRINKLER SUPPLY – CLOSURE WILL REMOVE SPRINKLER PROTECTION'**.

Each installation shall be fitted with a main stop valve, which shall be fitted with a supervisory device and secured open by a padlocked chain or strap. The location of the main stop valve shall be identified by signage '**SPRINKLER STOP VALVE'**.

Backflow protection is required for independent systems. Sprinklers that do not contain hazardous or toxic antifreeze are classed as a medium hazard and a double check valve backflow preventor is suitable. A Reduced Pressure Zone device backflow prevention will be required for high hazard.

Multi storey buildings having more than 6 floors shall have subsidiary stop valves provided at each floor to permit isolation of individual floors, or sections thereof, for service work. Levels below ground are to be included in the floor number.

Multi storey buildings having more than 6 floors shall have flow switches to indicate the floor on which the sprinkler system has operated. The indication shall be provided on a fire indication panel complying with NZS4512 in a location approved by the FENZ.

It is important to check the fire report, and design details for the sprinkler system ensuring the correct positioning of the sprinkler heads. Sprinklers other than residential type should not be spaced closer than 1.8m apart except where intervening constructional features provide a satisfactory baffle, in order to prevent the first sprinkler operating and wetting adjacent sprinklers.

Care must be taken to ensure sprinkler distances are kept away from obstructions like beams, joists, light fittings or ducts, so as not to cause undue interference with the discharge pattern, or the obstruction is to be treated as a wall or partition. Where the depth of the obstruction exceeds 300mm (combustible ceilings) or 450mm (non-combustible ceilings) and it is impracticable to position sprinklers at the required distance from the side of the beam, the beam shall be treated as a wall in relationship to the sprinklers in the adjoining bay.

A strainer shall be installed on every reticulated water supply where previous experience or test results indicate a need to eliminate particulate matter which could block a sprinkler or other system orifice. Strainers should have an open screen area at least $25mm^2$ for each litre per minute of highest design flow, and not less than four times the cross-section area of the supply pipe. Each orifice shall be at least 1mm smaller than the smallest sprinkler head or sprayer orifice used in the system which does not itself have a fitted strainer, but no smaller than 4mm.

In the sprinkler supply room, the deluge/dump valve shall have a drain to a FWG or gully trap, to the wastewater system.

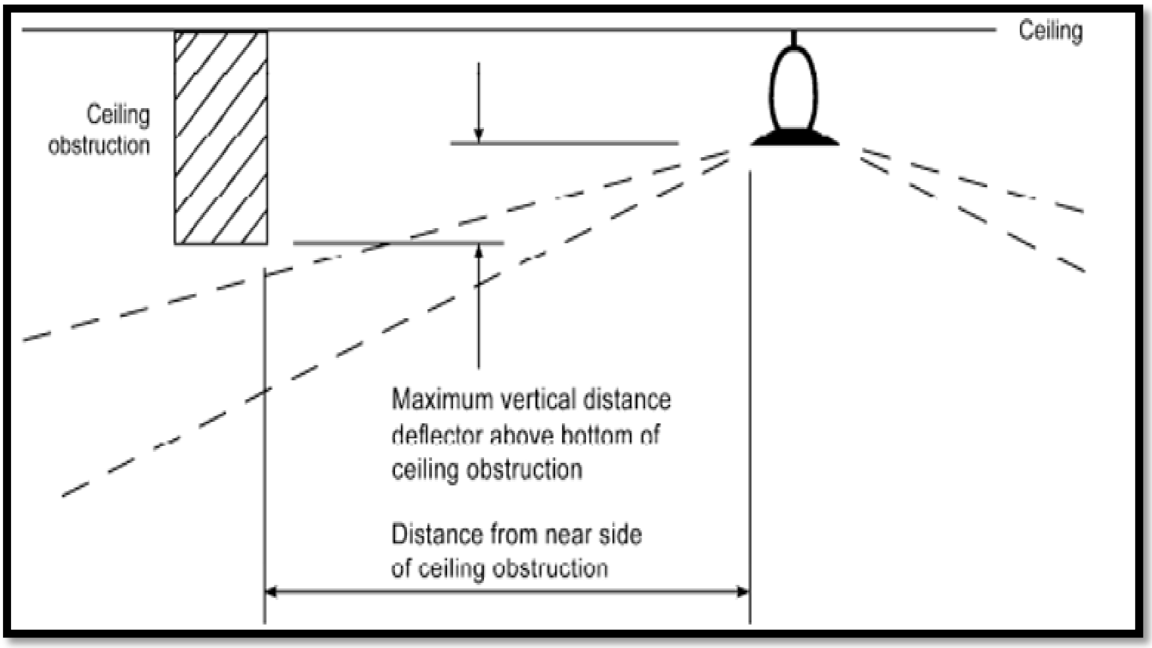


Figure above: NZS4541 fig 5.5- position of residential sprinkler deflector when located above the bottom of a ceiling obstruction.

Horizontal distance from sprinkler to near side of ceiling obstruction (mm)	**Maximum vertical distance permitted (see Figure 5.5)** (mm)
Up to 150	Not permitted
151 to 300	0
301 to 600	25
601 to 750	50
751 to 900	75
901 to 1050	100
1051 to 1200	150
1201 to 1350	175
1351 to 1500	225
1501 to 1650	275
1651 to 1800	350

Figure above: NZS4541 table 5.2 – Maximum distance of residential sprinklers above bottom of ceiling obstruction (where not specified by manufacturer)

Unless otherwise listed, upright sprinklers directly attached to pipework 100mm or larger shall be installed on sprigs of a distance three times greater than the nominal pipe diameter up to a maximum distance of 600mm. Upright sprinklers shall be installed at least 150mm away from rod hangers and similar obstructions. They shall be installed with the frame arms parallel to the direction of pipe to which they are fixed.

A clear space of at least 500mm shall be maintained below the level of the sprinkler deflectors throughout the room, except that in Extra High Hazard and Ordinary Group Hazard 4 occupancies this clear space shall be at least 900mm.

Where sprinkler heads can be easily knocked or damaged such as above a high wardrobe shelf or a low head height storage room, the head must be protected using a cage or similar to avoid accidental breakage.

Minimum horizontal distance from sprinkler to side of obstruction	Maximum height of sprinkler deflector above bottom of obstruction		Minimum horizontal distance from sprinkler to side of obstruction	Maximum height of sprinkler deflector above bottom of obstruction	
	Conventional sprinklers installed upright	Spray sprinklers (upright and pendent types) and conventional sprinklers installed pendent		Conventional sprinklers installed upright	Spray sprinklers (upright and pendent types) and conventional sprinklers installed pendent
(mm)	(mm)	(mm)	(mm)	(mm)	(mm)
100	–	17	1000	90	415
200	17	40	1100	110	440
300	25	70	1200	135	460
400	34	100	1300	170	460
500	42	150	1400	200	460
600	51	200	1500	230	460
700	60	250	1600	265	460
800	68	300	1700	300	460
900	78	360	1800	340	460

Figure above: NZS4541 table 5.1 Sprinkler distances from obstructions

Locations or conditions requiring special consideration

Solid waste and linen chutes

Solid waste and linen chutes which pass from one fire cell to another shall be protected shafts or contained within a protected shaft. Even if the building is un-sprinklered, each chute shall be equipped with automatic sprinkler head at the top connected to any water supply pipe capable of meeting the minimum design criteria for the selected sprinkler head. These sprinklers shall be installed at the top of each chute and in the space into which the chute discharges. The minimum residual pressure in the water supply pipe shall be 50kPa with two sprinkler heads operating. Solid waste and linen chutes shall have no inlet or discharge openings within an exit way. The hopper or access hatch must be fire rated if penetrates any fire cell.

In addition to the sprinkler requirement, chutes must also comply G15 requirements such as the following:

- Have a maximum opening diameter of 250mm.
- Have self-closing, tight-fitting doors to prevent odours escaping.
- Have an easily cleaned wall surface surrounding the opening for 300mm (this may be galvanised steel, ceramic tiles or similar material).
- Be located outside any dwelling or enclosed stair access and away from any habitable space or food preparation area.
- Have adequate ventilation, preferably by being located in the open air (e.g. on an outside balcony). Where hoppers are inside buildings, they shall be located in separate ventilated compartments complying with NZBC G4.

Escalators
Sprinklers shall be fitted under escalators and in the escalator boot and motor space. Where limited space prevents this, sprinklers shall be fitted in any surrounding ceiling space immediately adjacent to the escalator, regardless of the depth of the ceiling space.

Machinery pits and production lines
Machinery pits where waste may collect, and the underside of production lines shall be protected by sprinklers.

Hoists, lift shafts and enclosed chutes through floors
All hoists lift shafts and chutes inside, or in communication with, sprinklered buildings shall be protected by sprinklers. Sprinklers installed at the head of lift shafts shall be protected by stout metal guards.

Elevators, rope or strap races, gearing boxes and dust receivers
A sprinkler shall be fitted in the head of all seed and combustible product enclosed bucket elevators so that it can discharge down both sides of the elevator but can be omitted from elevators which are less than 8m high, have an internal cross section of each leg of less than $0.1m^2$ and do not penetrate any floor other than service platforms.

Sprinklers shall be fitted internally in all rope or strap races, gearing boxes and all enclosed belt or shaft machine drives.

Sprinklers shall be fitted in dust cyclones, collection chambers and boxes where these are housed within the protected building, erected outside and directly above the protected building unless the roof is of non-combustible construction, external to but connected with and closely adjacent to the protected buildings.

Where dust cyclones, collection chambers and boxes are erected above non-combustible roofs or are situated remote from the protected building at least one sprinkler shall be fitted inside the trunking where it leaves the protected building

In corn, rice, provender and oil mills: sprinklers shall be fitted not more than 3m apart inside all dust trunks which are more than 30° from the vertical and constructed of combustible materials, at the head of every dust trunk, and where centrifuges or similar machines are placed one above the another in tiers and are less than 1m from each other.

Bins and silos
All bins and silos of combustible or steel construction having a plan area in excess of $9m^2$ for the storage of flour, bran or other similar material which has undergone any process of reduction (in such premises as flour mills, granaries, oil mills or distilleries), or for the storage of sawdust, wood flour, pulverised coal and similar easily ignitable materials which can be extinguished by water, shall be internally protected by sprinklers on the basis of one sprinkler per $9m^2$ of the bin or silo area.

Canopies, doorways and set back external walls
Sprinklers shall be installed under all canopies where goods are stored or handled, and which communicate with the sprinkler protected building. Canopies which are of non-combustible construction and do not extend more than 2.3m from the wall of the building need not be fully protected if “cut-off” sprinklers are fitted under the canopy over each of the openings into the sprinkler protected building. Where such openings do not exceed 2.5m in width one sprinkler positioned centrally over each opening will suffice. Where openings exceed 2.5m in width the sprinklers over the opening shall be spaced not more than 2.5m apart and not more than 1.25m from the sides of the opening.

In the case of verandas and canopies over walkways around the perimeter of a protected building, sprinklers will not be required:

- over the portion of the walkway where the walkway is constructed of concrete and there is no exposure created by any combustible elements of construction of the canopy
- the walkway is a footpath owned by the city corporation
- is subject of a lease requirement to the effect that the walkway has to be kept clear of any objects in the nature of storage displays or otherwise

Where a building has recessed doorways where goods or refuse could be stored, such areas shall be sprinkler protected, unless the doorway has an FRR of -/30/30, and the doorway does not exceed 800mm depth and 2m width.

Where a part of an external wall is set back from the face of the building thereby forming a recess, sprinklers shall (except in the case of a doorway) be omitted from the exterior space thus formed only with approval which should be granted only where it is clear that there cannot be any combustibles in the recess and the walls and ceilings of the recess have not less than the FRR required by the Approved Document for the NZBC Fire Safety Clauses.

Recess depth (m)	≤0.6	>0.6-1.0	>1.0-2.0	>2.0_4.0	>4.0
	Nil	-/30/30	-/60/60	-/120/120	-/180/180

Exterior docks and platforms
Sprinklers shall be installed under the floor of exterior docks and loading platforms of combustible construction unless such a space is closed off against the accumulation of debris.

Enclosed paint lines, drying ovens and drying enclosures
Sprinkler protection shall be provided inside the above structures and ducts in which combustible materials can accumulate unless the sprinkler system certifier considers that no benefit would accrue. Sidewall sprinklers may be used for this purpose.

Extractor hoods and ducts
Extractor hoods over deep fryers, or other processes which produce flammable vapours or mists, require sprinklers under the hood. These shall be located in the flow path of the extractant with sufficient numbers to cover the area beneath the hood. Where filter banks are provided, the sprinklers shall be located below the filters. Sidewall sprinklers shall not be used. The provisions of this clause may be met by the provision of a listed kitchen fire suppression system, complying with UL 300. Such systems will only be acceptable for listing if they include the continuous discharge of water spray or water mist spray, to ensure that fire does not re-ignite following the discharge of any wet chemical fire suppressant agent.

Ducts where any cross section dimension is 300mm or greater and which are handling extractants that can lead up to build up in the duct of combustible material (including condensed flammable vapours and trapped fly) shall be fitted with sufficient sprinklers inside the duct to wet all interior surfaces and any electric motors therein. Permanent provision shall be made in the duct to allow replacement of such sprinklers.

Exhaust ducts shall have one sprinkler at the top of any vertical riser and at the mid-point of any offset. The first sprinkler in a horizontal duct shall be installed at the duct entrance. Horizontal ducts shall have sprinklers located at 3m centres, with the first sprinkler located at not more than 1.5m from the duct entrance. Refer to Figure 5.5 below.

In the case of commercial cooking hoods. A sprinkler shall be located between 25mm to 300mm above the point of the duct collar connection into the hood plenum. Hood exhaust plenums shall have one sprinkler in each chamber not exceeding 3m in length. Where a kitchen extraction hood is protected by a listed system (as mentioned in first paragraph above), and such a system is listed for the protection of ductwork, additional sprinkler protection is not required to be provided for sections of ductwork which provide extraction for a single kitchen hood only.

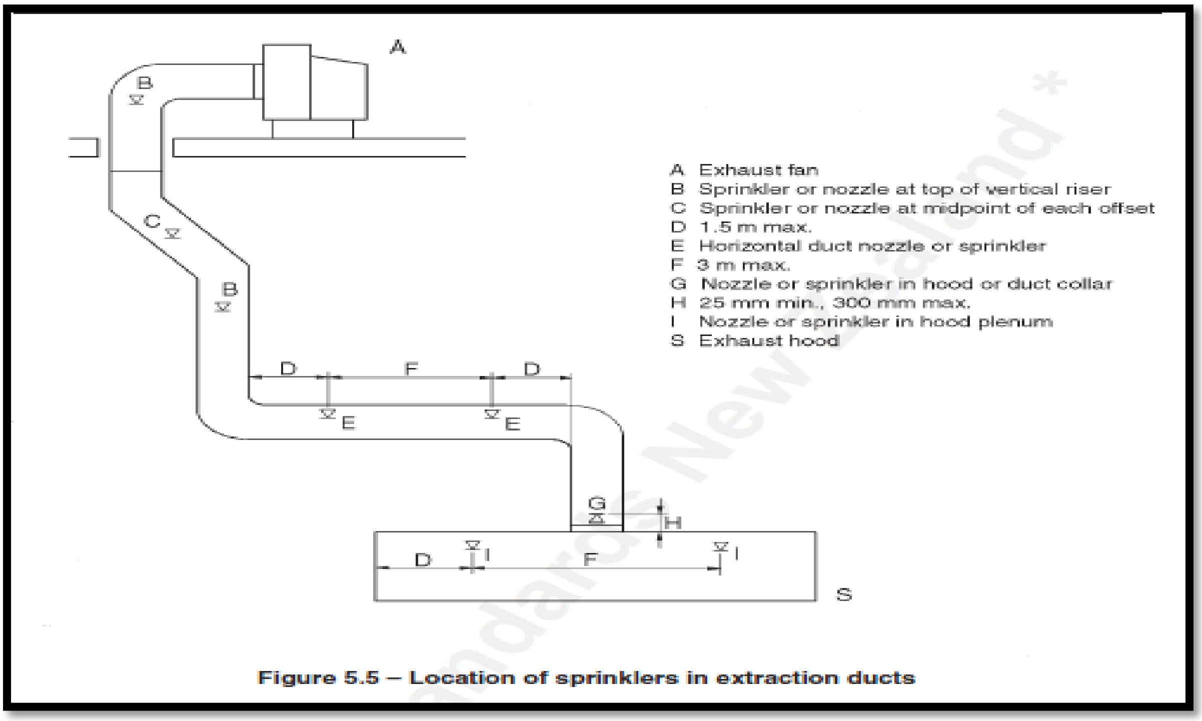
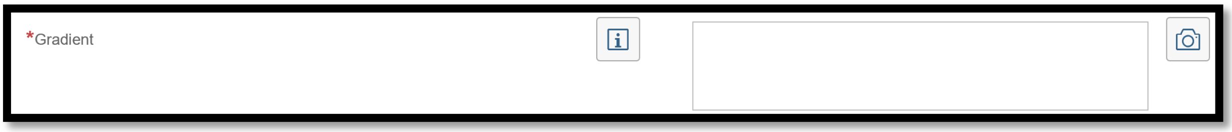


Figure 5.5 – Location of sprinklers in extraction ducts

Figure above: NZS4541 fig 5.5 location of sprinklers in extraction hoods

The inspector must take care to identify the spacing of sprinkler heads in accordance with the consented design. Special sprinkler design for car stackers, and racking will have different sprinkler spacing and position dependent on type of product being stored, height of racking, clearance above the racking, etc. The inspector shall always check the fire report and fire design specifications for full details.

Foul water



Figures above: Checklist line item 'Preline foul water pipe gradients compliant'

Figures above: Checklist line item 'Preline Foul water pipe material as per plan (check markings)

Figure above: Checklist Parent line item 'Preline foul water pipework installed correctly- sizes, layouts, joints primed/glued, supported, vents, lagging and label.

Note: When completing this parent line item, consideration must be given to cover all relevant child line items.

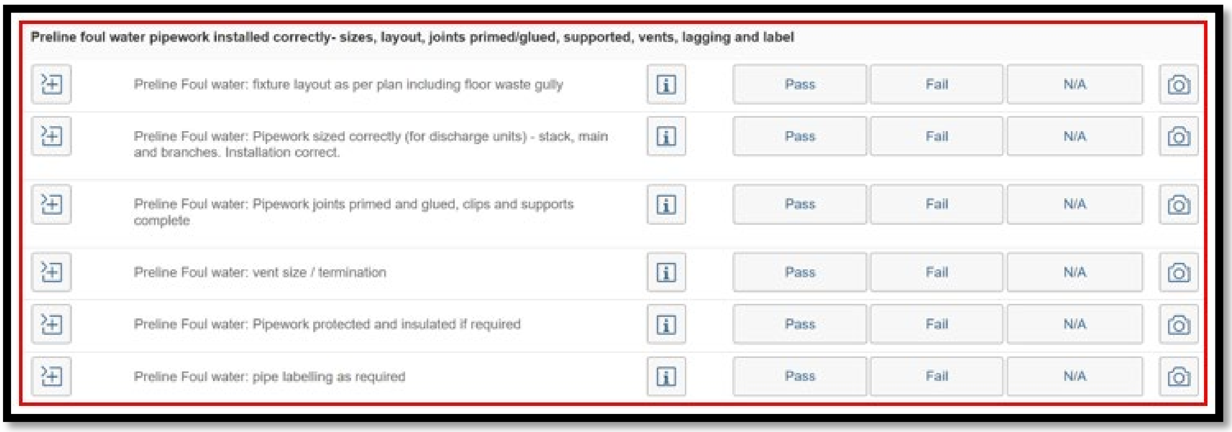


Figure above: Checklist Child line items

A plumbing system is defined as pipes, joints and fittings, laid above ground and used for the conveyance of foul water to the foul water drain and include vent pipes.

The inspector must ensure that the fixture layout and foul water system is in accordance with the consented plans.

All pipework must be primed and glued with approved plumbing products.

Pipes must be clipped and supported to either roof or subfloor framing as applicable. Centres are determined by the size of the pipe.

TABLE 10.2.1

MAXIMUM SPACING OF BRACKETS, CLIPS AND HANGERS

Pipework material	Maximum spacing of supports m	
	Vertical pipes	Graded pipes
Cast iron	3	3
Ductile iron	3	3
Copper, copper alloy	3	3
FRC	4	4
PVC-U DN 40–50	2	1
PVC-U DN 65–150	2.5	1.2
PVC-U DN > 150	3	1.5
PP	2	1
PE	2	1

Figure above: AS/NZS3500.2: 2018 table 10.2.1 Pipe fixing spacing

Stacks

A stack system is a vertical discharge pipe (including offsets) which continues through more than one floor. They can generally be divided into two main categories, **fully vented** and **single stack**, with two main distinguishing features.

Fully vented allows several fixture discharge pipes to be combined in a common discharge pipe before joining the main stack, but with **single stack** systems every individual fixture discharge pipe enters the stack separately - there are no combined wastes.

Fully vented modified stack system

Fully vented modified is one of the most common systems used, both for commercial (multi-storey) and residential (2 or 3 floor) constructions. The modified part of the title refers to the fact that instead of every fixture having a vent, groups of two or more fixtures that discharge to the same graded pipe or branch are vented by one or more group vent or AAV. In other words, the **branch** is vented not the individual fixture.

There are many detailed rules regarding both vents and discharge pipes, the most important being:

- The size of the common discharge pipe will be determined by the total load measured in fixture units as per the table to the left.
- One group vent for each 10 fixtures.
- The first vent connected to the discharge pipe of the most upstream fixture at a maximum distance of 1.5m from the fixture trap.
- Second and additional vent to be spaced by dividing the number of fixtures into equal groups (approximately).

- If a vertical drop occurs in the common pipe and fixtures are connected to the lower section, a vent is provided.
- Vents can be combined above flood height and connected to the relief vent. Sizing of the vent system is very specific and calculated.

TABLE 8.2.2(B)

MAXIMUM LOADINGS ON STACKS IN FIXTURE UNITS

Size of stack DN	Maximum loading per floor level	Maximum loading per stack
(a) Four or more floor levels		
40	4	16
50	9	36
65	14	56
80	20	80
100	125	500
125	250	1000
150	600	2400
225	1750	7000
(b) Three or fewer floor levels		
40	2	6
50	5	15
65	6	18
80	13	40
100	65	195
125	150	450
150	250	750
225	950	2850

Figure above: AS/NZS3500.2: 2018 table 8.2.2 FU loadings to stacks

There are rules on the fixture pipes connected to the common pipe:

- The maximum length of a 100mm fixture discharge pipe is 6m.
- All other fixture discharge pipes maximum length is 2.5m.
- In addition, basins and bidets to have a maximum vertical drop of 1.5m, other fixtures a maximum vertical drop of 2.5m.
- A maximum number of bends in each discharge pipe.

Fixture	Horizontal plane	Vertical plane
Basins and bidets	2	2
All other fixtures	2	3

Figure above: maximum number of bends allowed on fixture discharge pipes, applies to all stack systems.

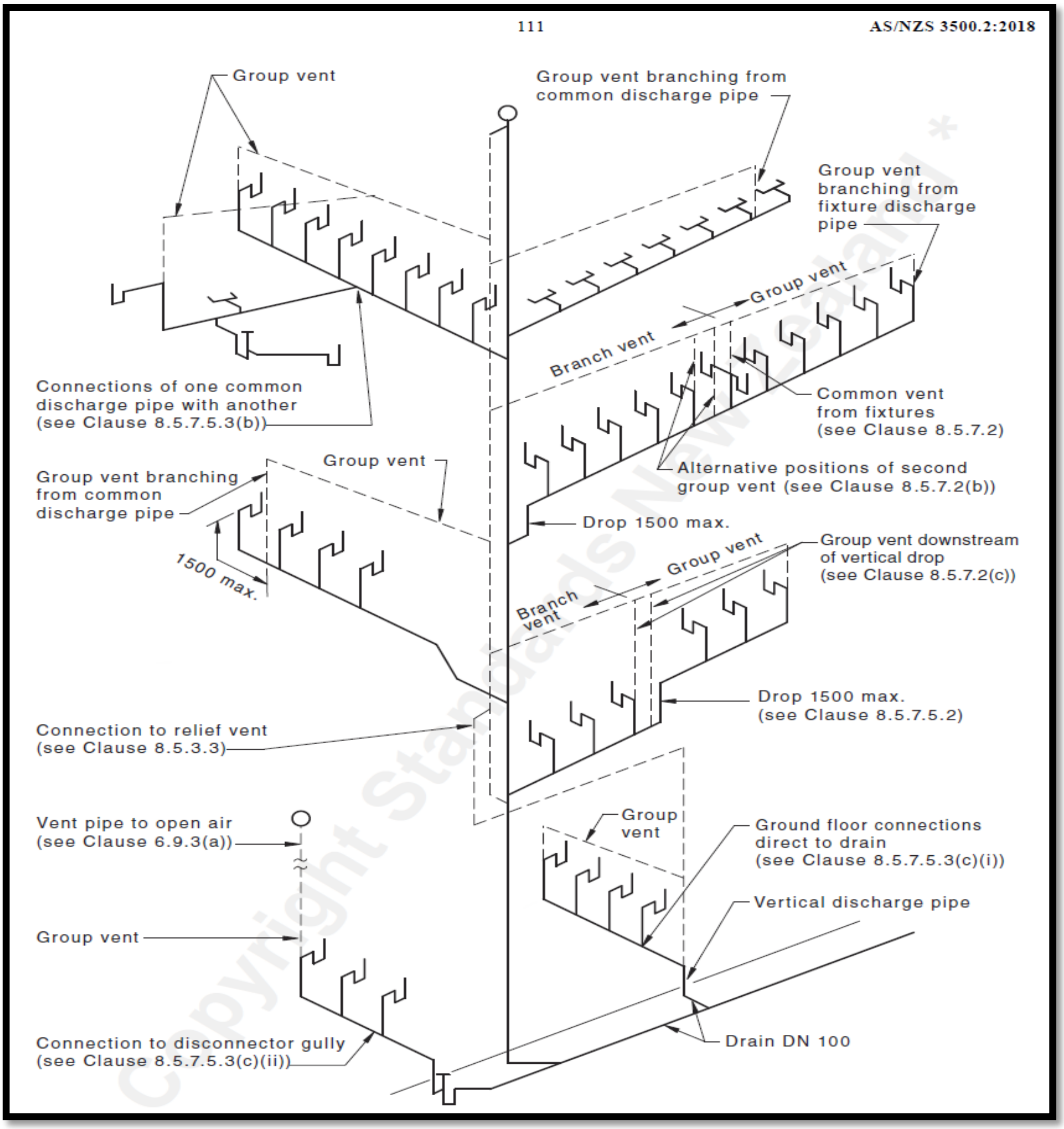


Figure above: AS/NZS3500.2:2018 fig8.5.7.5.1 typical fully vented modified system showing group vents.

The vents from each branch may be replaced with an AAC, however, the relief vent is still required in this case as the stack is over 3 storeys.

Single stack system

Single stack systems are designed on the principle that all fixture and branch vents can be removed from the design provided strict rules on pipe size, gradient and length are observed. There are many other restrictions on total loading, as well as loading per floor.

They are most appropriate for apartment buildings of up to 30 floors, where mirror image apartments have an identical layout floor after floor.

Apart from the variations detailed below, the stack will be 100mm diameter. There are different rules for residential and commercial.

Single stack residential:

- No relief vent required even though it exceeds 3 floors.
- All fixtures connected to the stack individually, or through floor waste gullies.
- Maximum length of fixture discharge pipes 6m for 100mm pipe, 2.5m for all others.
- There are both minimum and maximum gradients for discharge pipes.

Fixture diameter min	Max length	Grade %
Waste fixtures	2.5	2.50 to 5.00
WC pans, 100mm	6.0	1.65 to 5.00
WC pans 80mm	2.5	1.65 to 5.00
Urinals 50-80mm	2.5	2.50 to 5.00
100mm	6.0	1.65 to 5.00

- If the discharge pipe is over length a trap vent or AAV is required.
- There is a significant number of minor variations and specific conditions found under AS/NZS3500.2:2018 9.5.2 which should be referred to in cases of doubt.
- There are a number of specific variations which are particularly well suited to residential situations up to 3 floors as detailed below.
- 2.5m is measured to FWGs so an extra 2.5m may be gained by using that.

There are serious limits to the loading capacity of these unvented systems, the number of floors it may pass through, and to the type and number of fixtures able to be connected.

Size of stack mm	Maximum loading FUs	Max consecutive floor levels
100	260	10
125	390	15
150	780	30

In addition to the maximum loading, there are limits to the number of fixtures allowed per floor. No more than 2 fixtures of the same sort may be connected to a single stack from any floor level in a residential building.

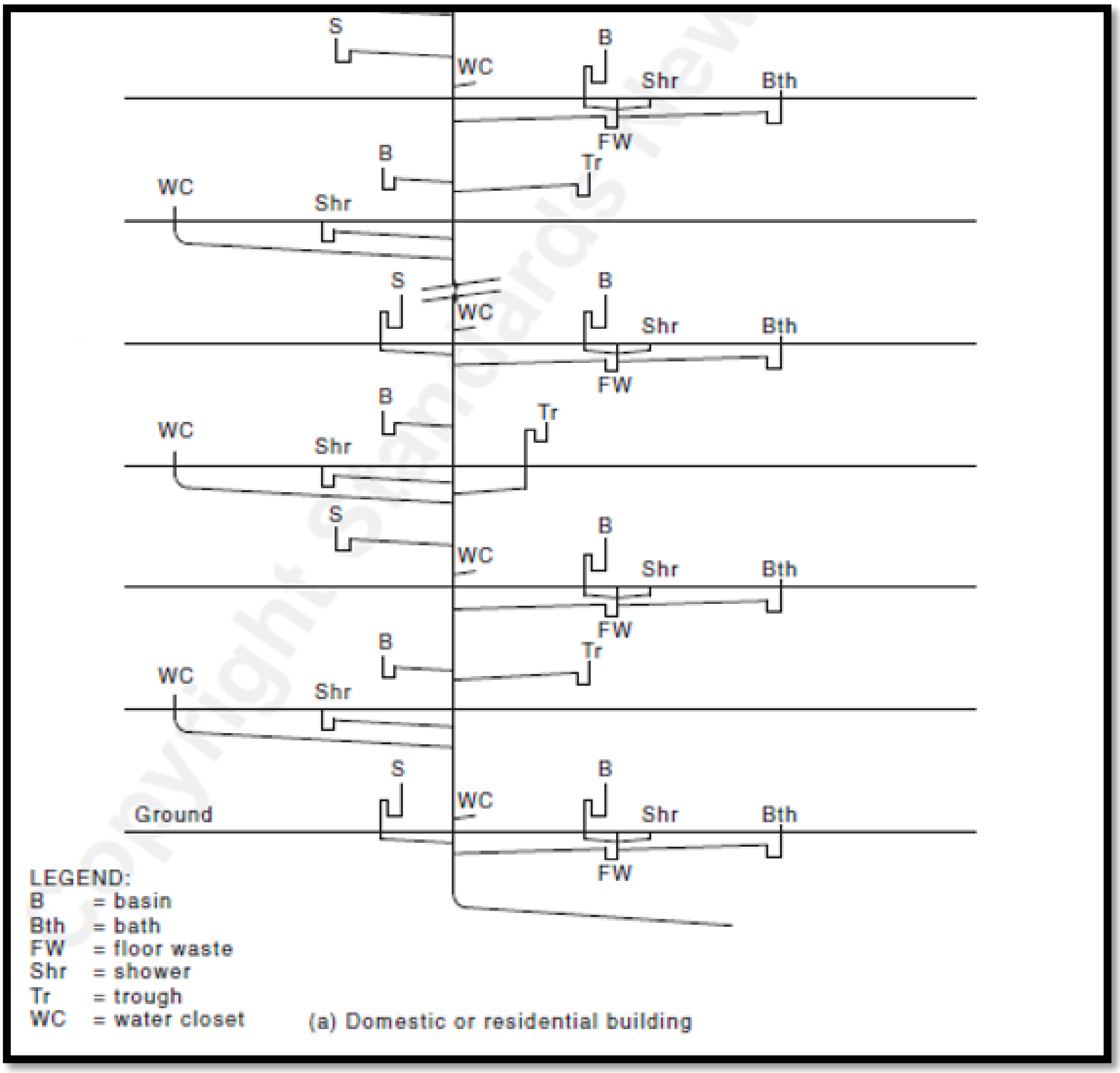


Figure above: AS/NZS3500.2:2018 fig 9.2.2 example of residential single stack modified system

Variations to single stack

Stacks may be installed less than 100mm diameter, but these have serious restrictions:

- An 80mm stack serving up to 3 floors without offset (except above the highest fixture as a vent) and receiving discharge from only wastewater fixtures, e.g. no WC and no laundry and clothes washing machine
- An 80mm stack serving not more than 2 floors with the top section graded nominally horizontal and receiving discharge from only wastewater fixtures, e.g. no WC and no laundry or clothes washing machine. No fixtures connected to the vertical section of the stack and no connection within 450mm from the lower bend on the horizontal section.
- A 65mm stack serving not more than 2 floors may receive the waste from not more than 2 kitchen sinks, or one kitchen sink and one laundry trough separately connected at each floor.
- After the graded pipe is reduced to 50mm and continues vertically as a vent, a maximum of 3 waste fixtures (basin, shower or kitchen sink only) may connect to the vertical section (max stack loading 30 FUs).

In the top 2 cases, only one bath, basin, shower, sink and dishwashing machine may be connected per floor, or to the graded section. Each connection must be as individual pipes, no combined wastes.

Single stack commercial

The 2 major differences between single stack residential and commercial are:

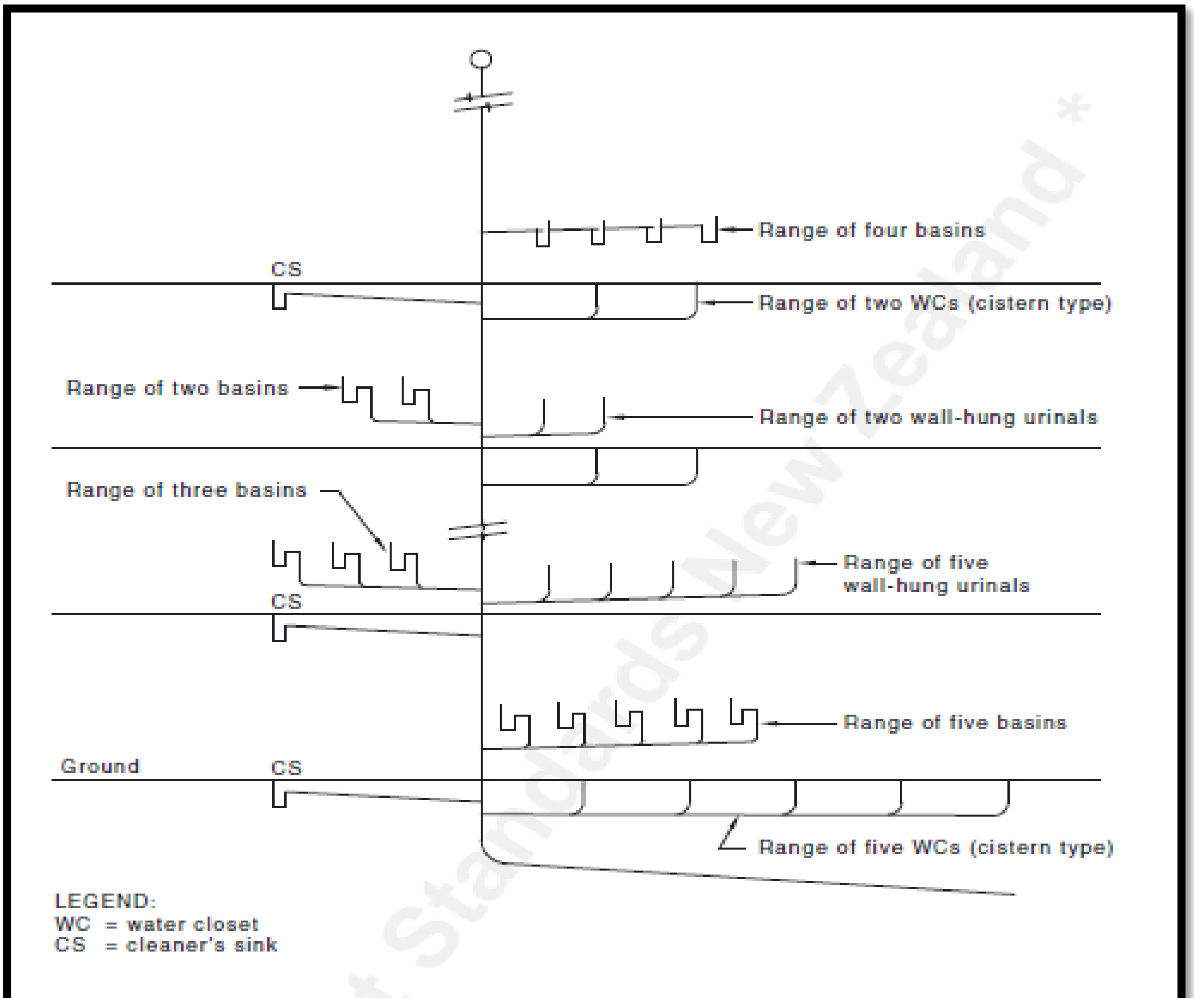
- Commercial systems may combine a range of the same type of fixture to a common discharge pipe, unvented.
- A much lower loading per stack and fewer floors per stack

Size of stack mm	Max loading FUs	Max consecutive floor levels
100	60	4
125	100	6
150	200	8

In addition to the maximum loading above, there are limits to the number of fixtures allowed per floor. For a range of fixtures, a maximum of 5 basins, WCs or wall hung urinals.

For individual discharge pipes, the following limits apply:

Basins	5
Cleaners sink	1
Drinking fountain	1
Sink	1
Wall hung urinals	5
WC pans	5
Showers	2
3m slab type urinal	1
Bar sinks	2
FWG; total for all combined	5 basins 1 drinking fountain 1 cleaner sink 2 showers



(b) Commercial or industrial building
(see Table 9.7.1(B))

Figure above: AS/NZS3500.2:2018 fig 9.2.2 example of commercial single stack system

When combining a range of similar fixtures, the following limitations apply to the fixture discharge pipes and the combined pipes.

Fixture discharge pipes				
WC x 5 max	Length	Bends	Grade	Traps
80mm	1.5m S-trap	Max2	1.65 to 5%	Max 6m to stack or adjacent traps
Common discharge pipe				
100mm	10m	Max2; Max2x45° on horizontal plane	1.65 to 5%	

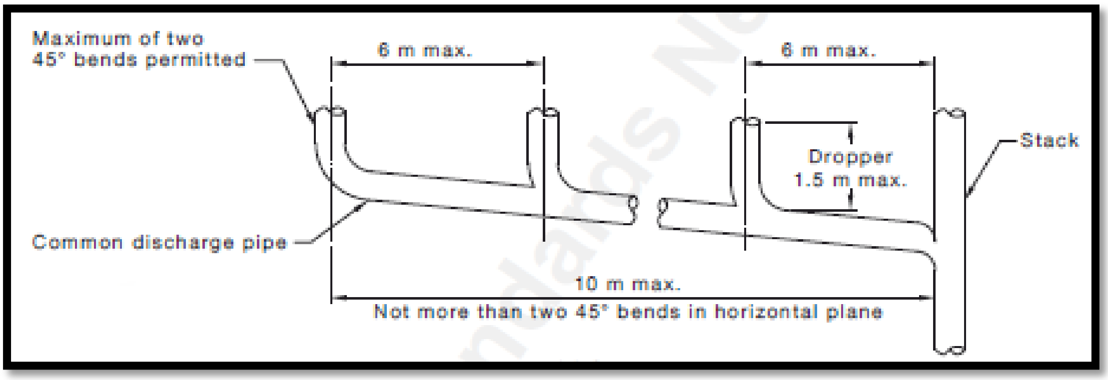


Figure above: AS/NZS3500.2:2018 fig 9.5.12b example of range of WC pans

Fixture discharge pipes				
Basins x 5 max	Length	Bends	Grade	Traps
40mm	Max 1m	Max 1	2.5 to 5%	Max 2m to stack or adjacent traps
Common discharge pipe				
50mm	Max 4.5m	No bends allowed	2.5 to 5%	

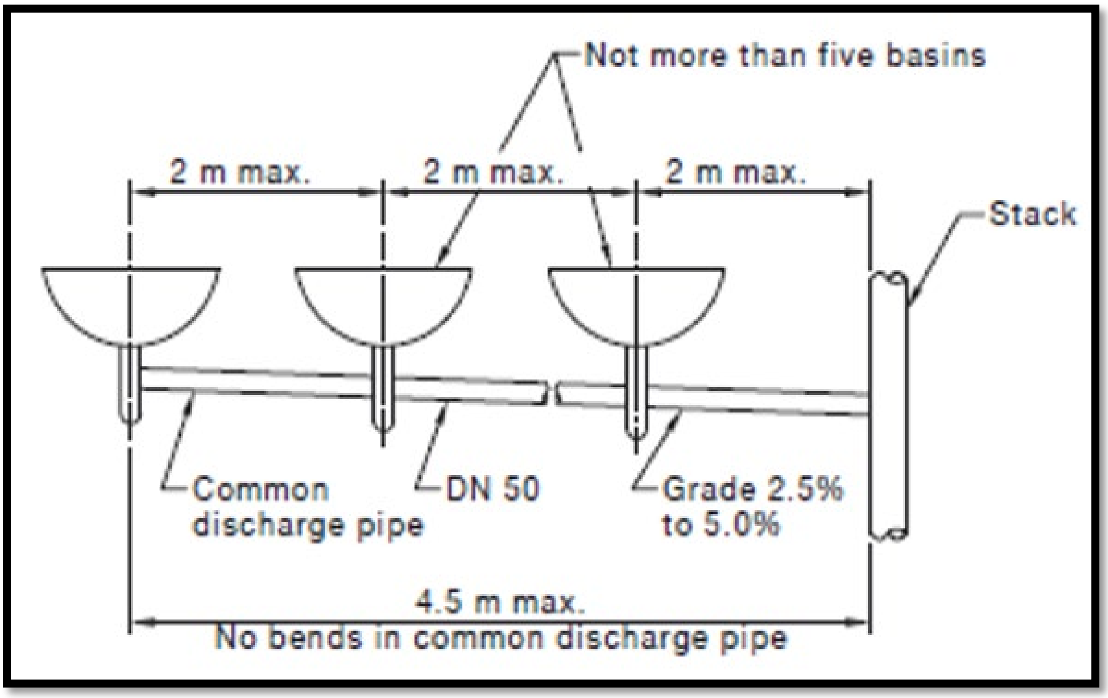


Figure above: AS/NZS3500.2:2018 fig 9.5.11a example of range of basins

Fixture discharge pipes				
Wall hung urinals x 5 max	Length	Bends	Grade	Traps
50mm	Max 1m	Max 1	2.5 to 5%	Max 2.5m to stack or adjacent traps
Common discharge pipe				
65mm	Max 10m	Max 2	2.5 to 5%	

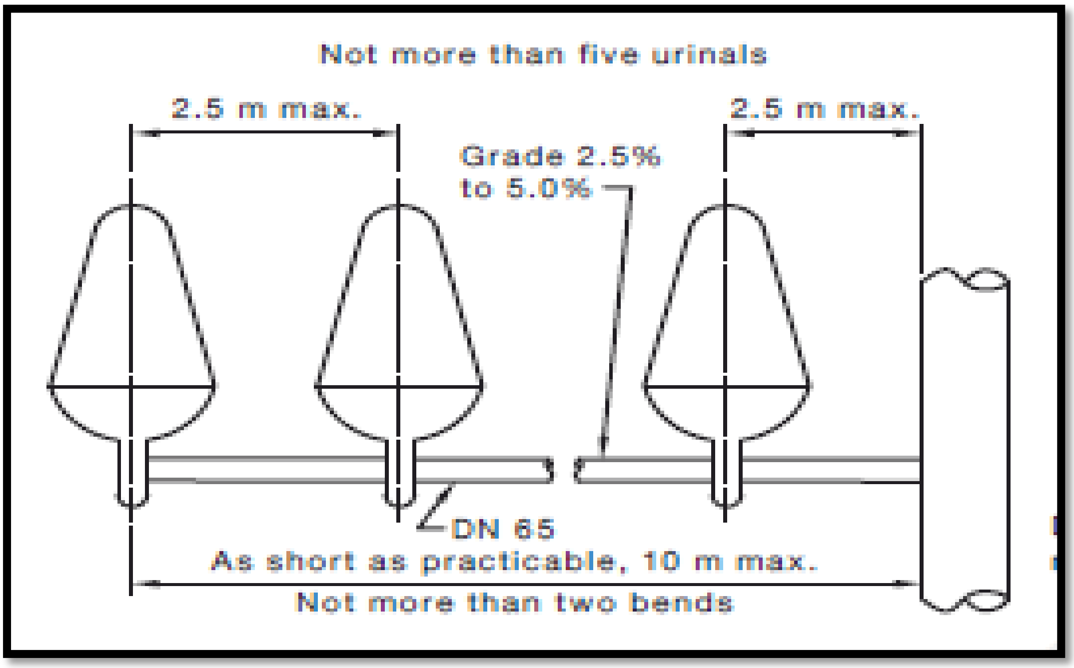


Figure above: AS/NZS3500.2:2018 fig 9.5.13.1 example of a range of wall-hung urinals

Single stack modified system

The single stack modified system involves installing a relief vent and then cross connecting the vent with the stack at regular intervals. Individual or branch vents are not used, but the system allows for a greatly increased loading over more floors to be applied.

An alternative to the cross vent is to use a **pressure attenuator (PAPA) valve.** Refer section on PAPA valves later in this module.

The relief vent as with fully vented systems connects at the base below the lowest fitting and above the highest fitting, both at 45°. The difference with the fully vented system is that instead of vents each fixture connecting to the relief vent, cross vents connecting the relief vent with the stack are fitted at regular intervals.

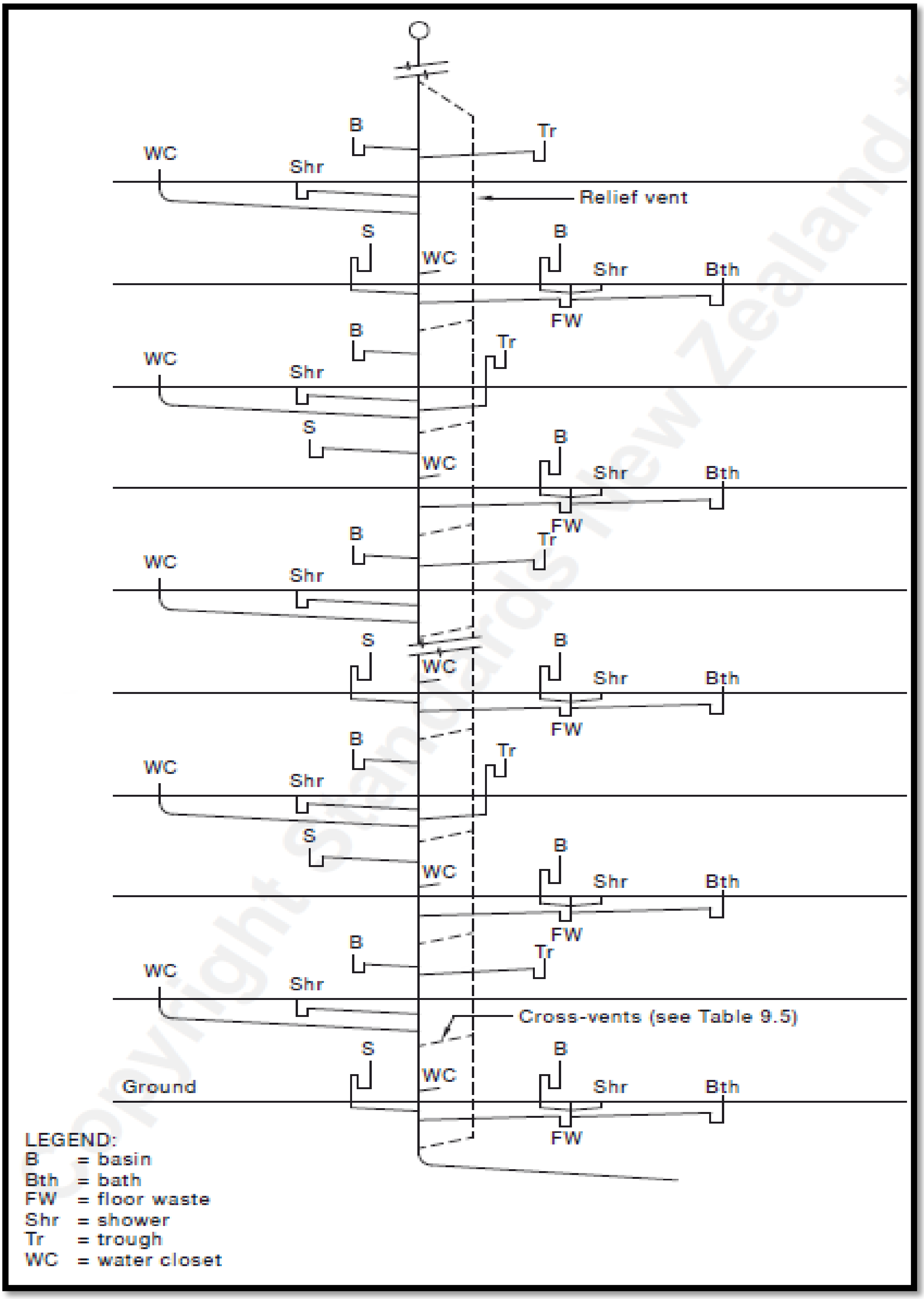


Figure above: AS/NZS3500.2:2018 fig 9.2.3 example of single stack modified system

The frequency and size of the cross vent (which is fitted at 45° to both the vent and stack) depends on fixture loading and number of floors and differs considerably between residential and commercial.

Single stack modified residential				
Size of stack mm	Max FU loading	Number of consecutive floor levels	Size of relief and cross vents mm	Location of cross vents
100	290	Up to 15	50	Alternate floors
100	390	Up to 15	50	Each floor
100	320	16 to 20	65	Alternate floors
100	500	16 to 20	65	Each floor
Single stack modified commercial				
100	120	5 to 12	50	Each floor
125	250	13 to 18	65	Each floor
150	600	19 to 24	80	Each floor

Figure above: single stack modified system fixture unit loadings, AS/NZS 3500.2:2018 tables 9.7

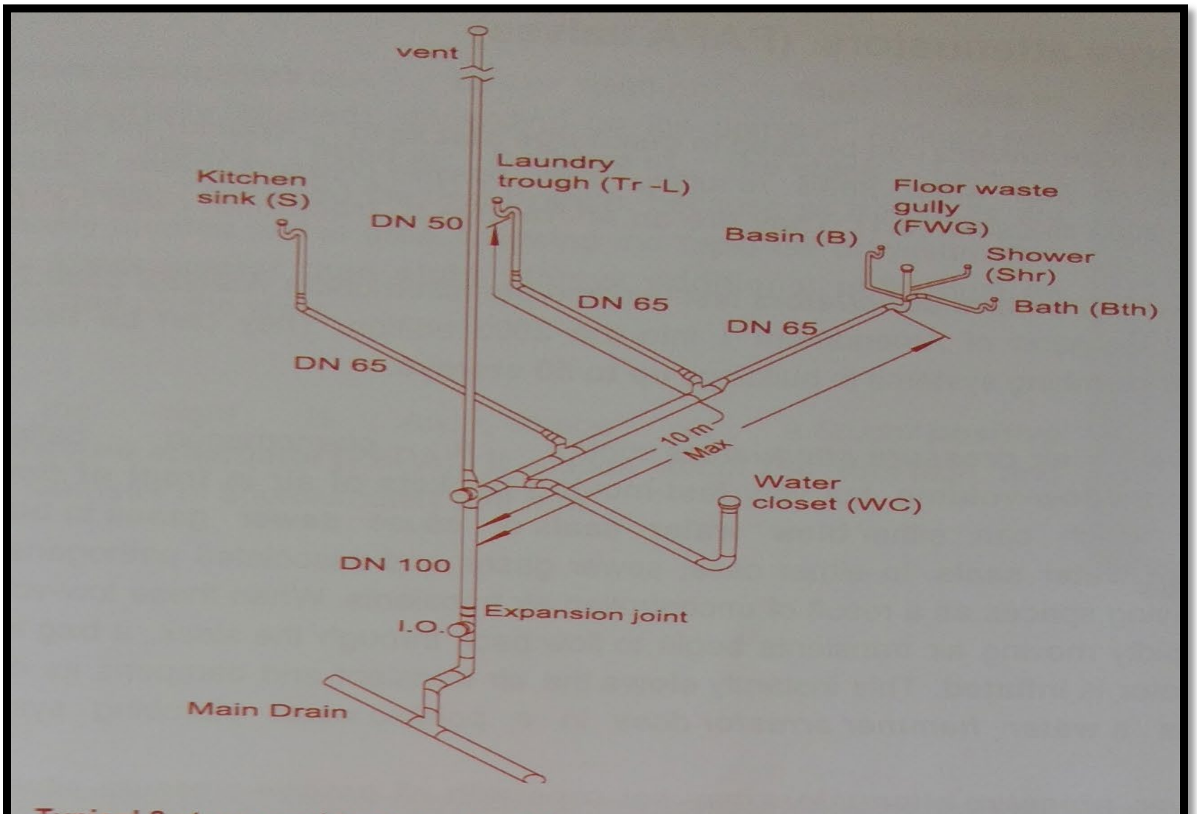
Drainage principles

Above ground elevated pipework using drainage principles works on the fact that if drains work below ground without causing seal problems then if the same rules (sizing, length, and gradient) are used above ground then it will work there, but strict rules apply:

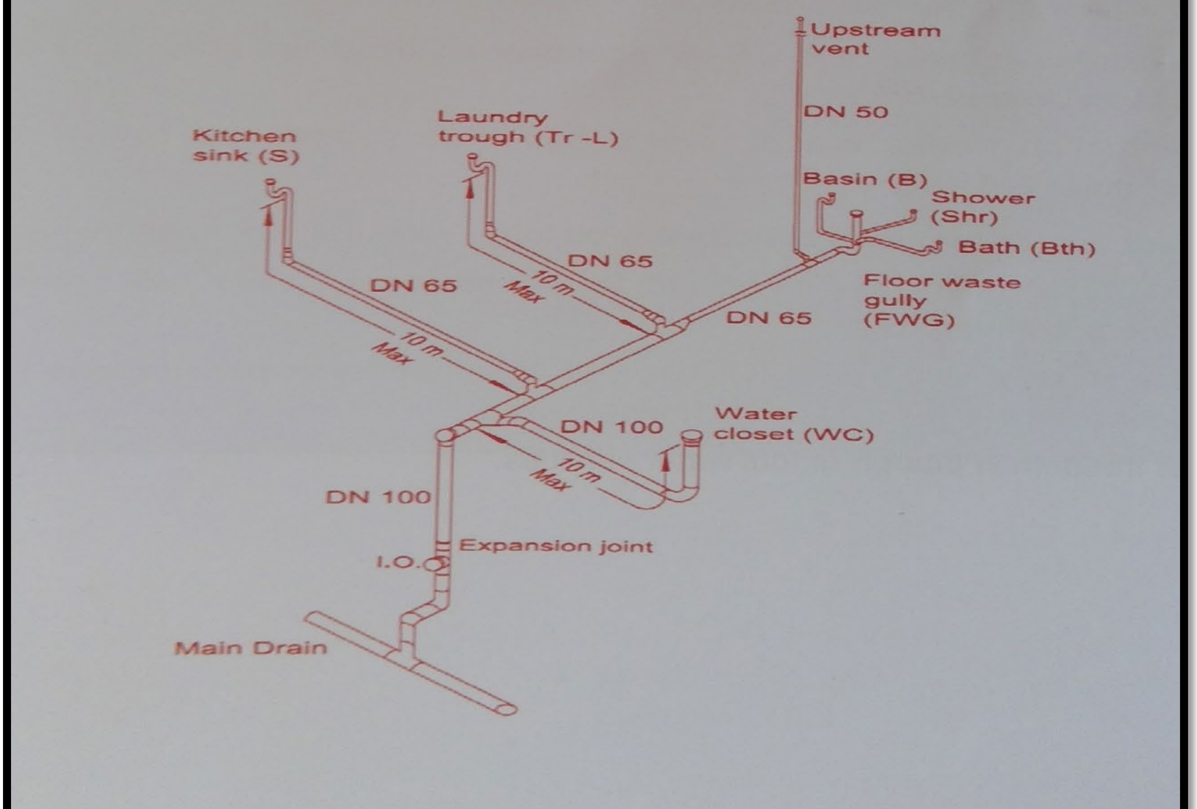
- In multi-storey buildings it can only be used on the first four floors and the top floor, with intervening floors being served by a nominated stack system.
- All branches enter the stack on the horizontal sections, **never** on a vertical section except the top floor (example 2nd floor of a 2-storey house).
- The minimum diameter of a branch is 65mm, reducing to fixture size (usually 40mm) between the fixture and the horizontal branch.
- The maximum unvented length of branch is 10m. Several fixtures can join a branch and the 10m distance is measured individually along the pipe from each fixture to the main drain.
- Be aware of maximum fixture units for branches based on pipe diameter.

Diameter	Min grade	Max FUs	Other restrictions
65	2.5%	5, or 10 from a FWG	No WC or slop hopper
80	1.65%	12	Max 1 WC or slop hopper
100	1.65%	30	2 pans or slop hopper

Figure above: sample of size of unvented branch drains, maximum gradient and maximum fixture loading AS/NZS 32500.2:2018 table 3.10.2



Typical 2 storey residential using Elevated pipework using drainage principles.



Alternative venting using Drainage Principles.

Figure above: examples of plumbing utilising 'drainage principles'

Restricted zones

When wastewater enters a stack at a junction, or changes direction suddenly (vertical to horizontal, or horizontal to vertical) positive or negative pressures are generated. The greatest pressures are at the base of the stack where what are known as **Transient Pressure** pulses are generated. These can travel through the stack at approximately 340m/s (speed of sound).

For this reason, all stack systems must have restricted zones at the base of the stack. This zone reflects where waste flowing from a branch would strike the wall of the stack. Any other pipe in that area could have liquid waste forced up the other branch causing loss of seal or deposited solids.

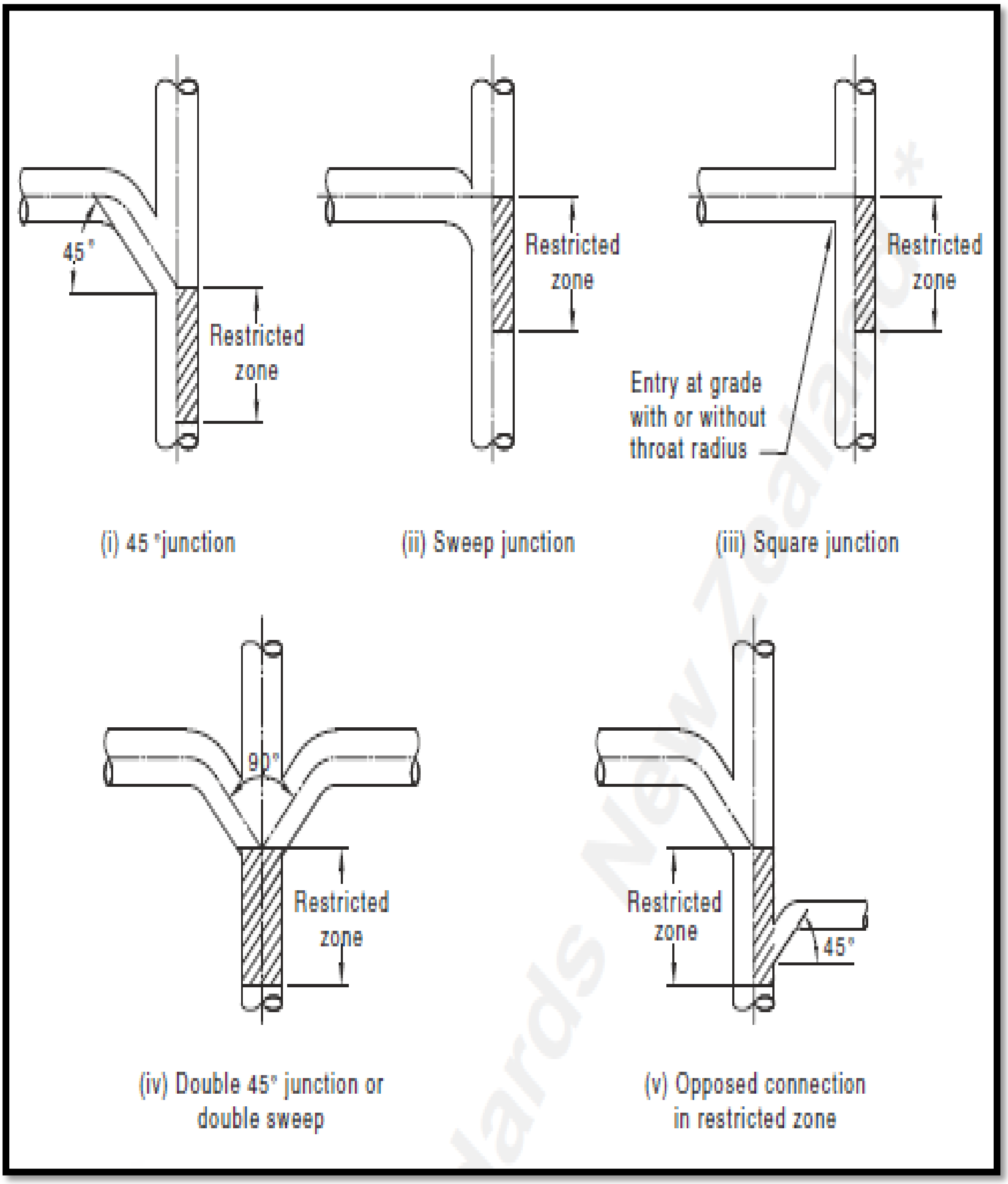


Figure above: AS/NZS3500.2:2018 fig 6.7.3.2 zone restrictions for stack connections

Discharge pipe mm	Stack size mm	Restricted zone vertical depth mm
46 to 65	40 to 80	90
	100	110
	125	210
	150	250
80 upwards	80 upwards	200

Figure above: restricted entry zone requirements AS/NZS 3500.2:2018 table 6.7.3.2

Connections at the base of stacks

At the base of the stack where it joins the drain there may be a single bend of 88° if the stack extends through no more than 2 floors. More than that and there must be 2 x 45° bends (nominal).

For stacks no more than 2 floors no connection is to be made within 500mm of the connection to the drain, upstream or downstream.

For stacks 3 floors and above this extends to 1m upstream, 2.5m downstream, or 1m upstream at the grade.

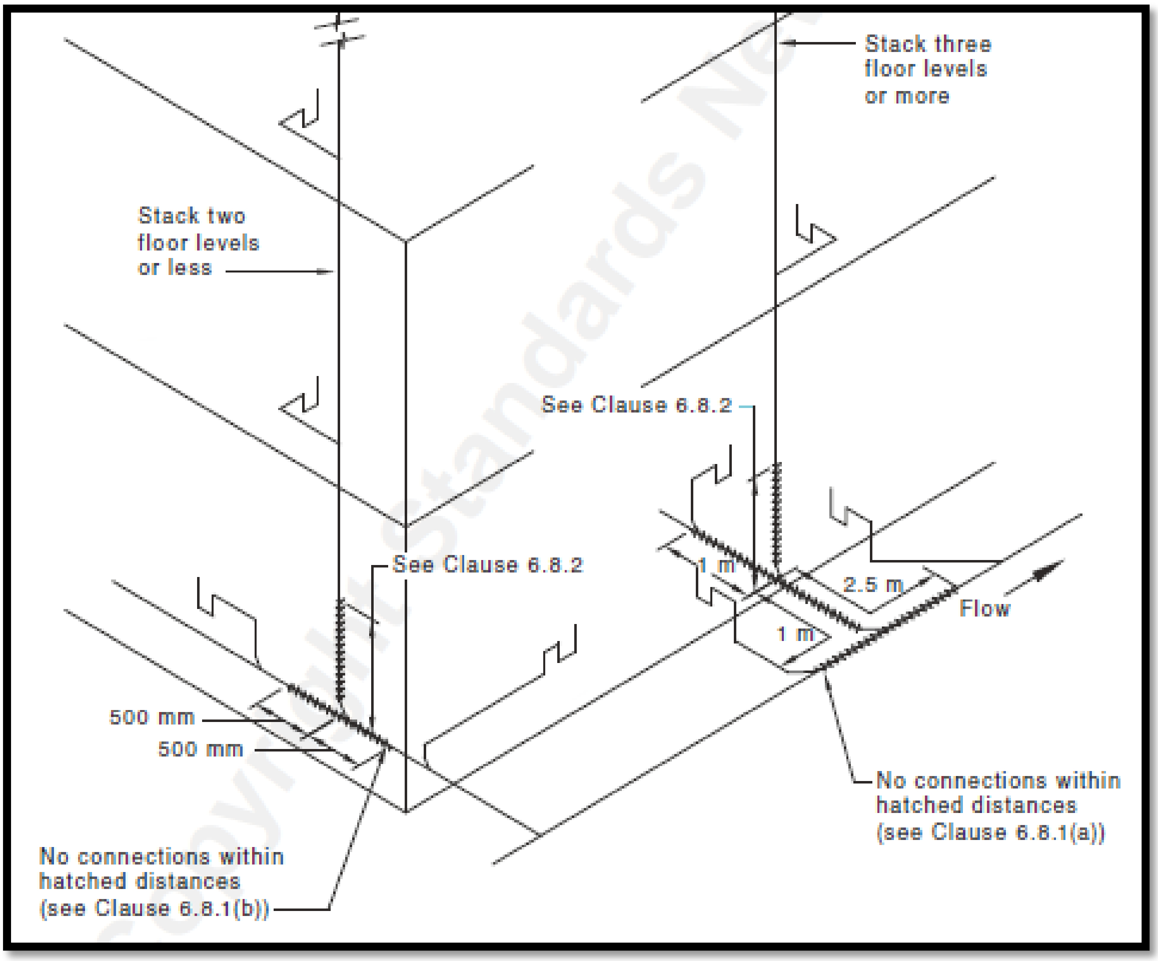


Figure above: AS/NZS3500.2:2018 fig 6.8.1 connection restrictions at or near base of stack

Graded offsets

There are four specific restricted zones on graded offsets which involve the two vertical sections and the horizontal section joining them

Upper vertical section

Above the bend the restricted zone is 600mm if the stack extends up to 5 floor levels above the offset, 1m if it extends more than 5 floor levels, and 2.5m if foaming is likely to occur.

Horizontal section

At top of section 2.5m from the bend, and from lower bend 450mm.

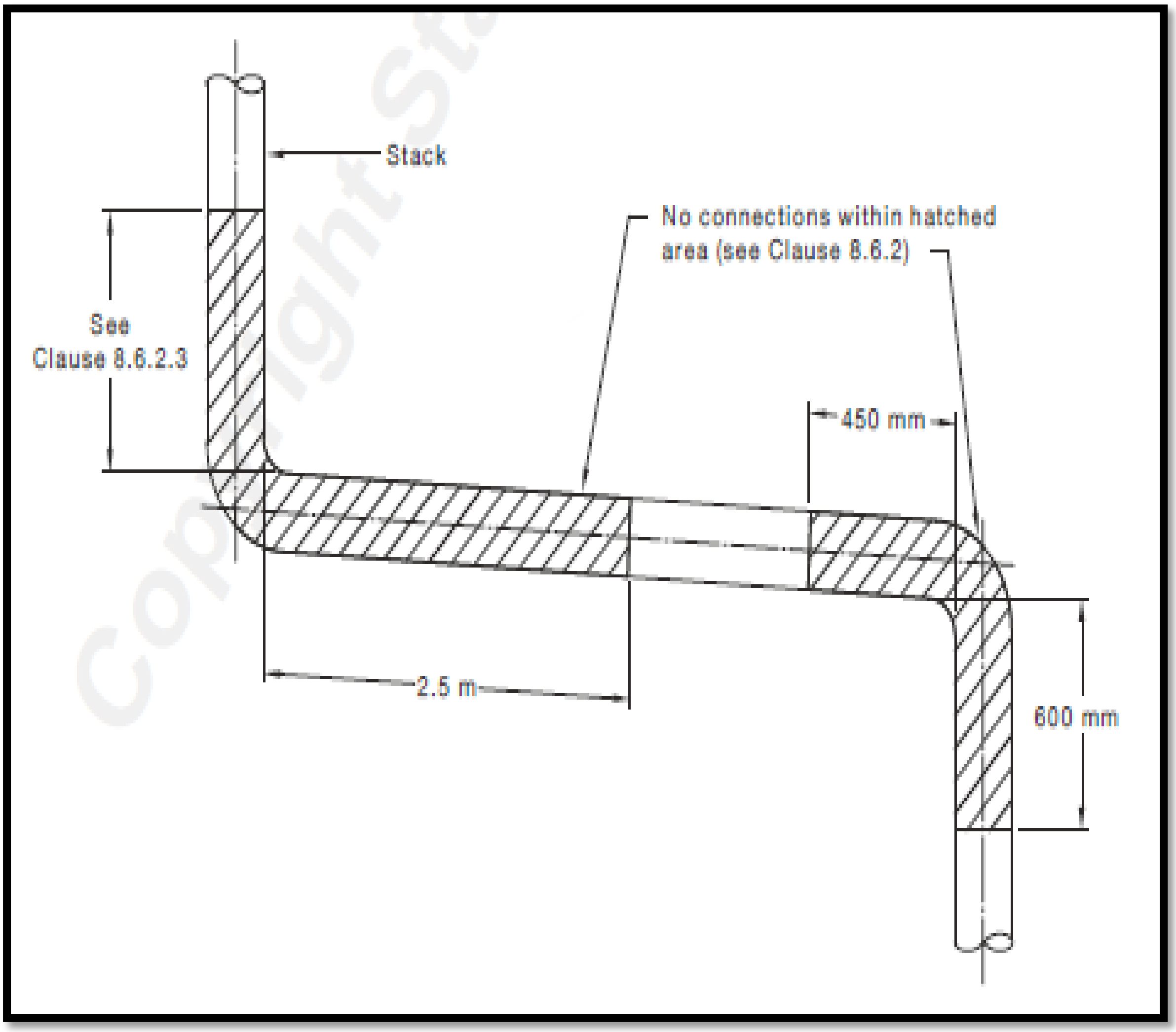


Figure above: AS/NZS3500.2:2018 fig 8.6.2.4 connection restrictions at offset of stack

Fully vented (G13/AS1 foul water)

Fully vented as the name implies is a system where every fixture and appliance are individually vented. The only exceptions being individual discharge pipes to a gully trap (ORG or disconnector), where the pipe is less than a specified length. In the case of G13 AS1, this length is 3.5m, but using AS/NZS3500.2 longer lengths may be achieved using a larger diameter pipe, up to 10m.

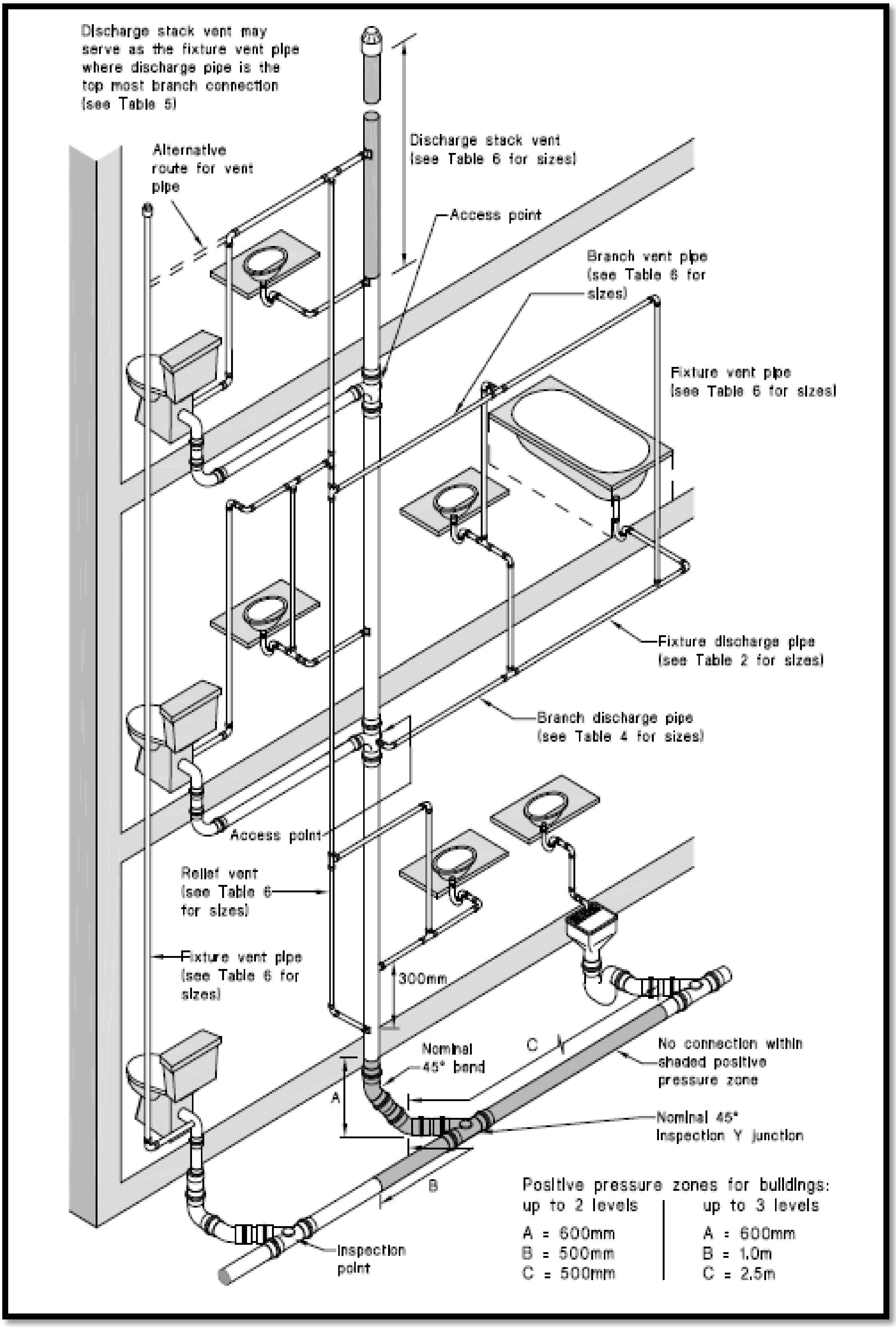


Figure above: G13/AS1 fig 7 vertical discharge stack

In most cases the vent can be replaced with an Air Admittance Valve (AAV) but due to the costs and inconvenience of this system it is seldom used today, except for single floor individual dwellings with wooden (suspended) floors.

When it is used then stacks 3 floors and over require a relief vent with restriction zones similar to other stack systems.

Pipe size	DU loading		Min gradient Max length		Max length	
	AS1	AS3	AS1	AS3	AS1	AS3
32mm	1	N/A	1:20	N/A	3.5m	N/A
40mm basin or bidet	1	1	1:40	2.5%	3.5m	3.5m
40mm	4		1:40	2.5%	3.5m	6m
40mm	5		1:30	3.35%	3.5m	6m
40mm	6		1:20	5%	3.5m	6m
50mm	8		1:40	2.5%	3.5m	6m
50mm	10		1:30	3.35%	3.5m	6m
50mm	15		1:20	5%	3.5m	6m
65mm	21		1:40	2.5%	3.5m	10m
65mm	29		1:30	3.35%	3.5m	10m
65mm	51		1:20	5%	3.5m	10m

Figure above: table of waste pipes to gully traps – combination of AS1 and AS3

Terminal Vent

The purpose of a vent pipe is to protect water seals and ensure that where it terminates it is either open to the atmosphere or fitted with an AAV and that at its lower end is connected to a discharge pipe.

Key points of a vent pipe are:

- continual rise and gradient of 1:80 from the point of connection to the open air (to stop condensation / liquids restricting venting)
- terminates in open air and is fitted with a device to stop birds getting into it
- terminates at least 50mm above overflow level of the highest fixture served

The termination points must be:

- 3m above ground
- 600mm above eaves or parapet
- 150mm above roof
- 600mm above and 3m horizontally of the head of an opening window, door or skylight
- 3m above and 3m horizontally from a deck
- 5m above any air intake
- 2m above and 600mm below and 3m horizontally from a chimney/flue

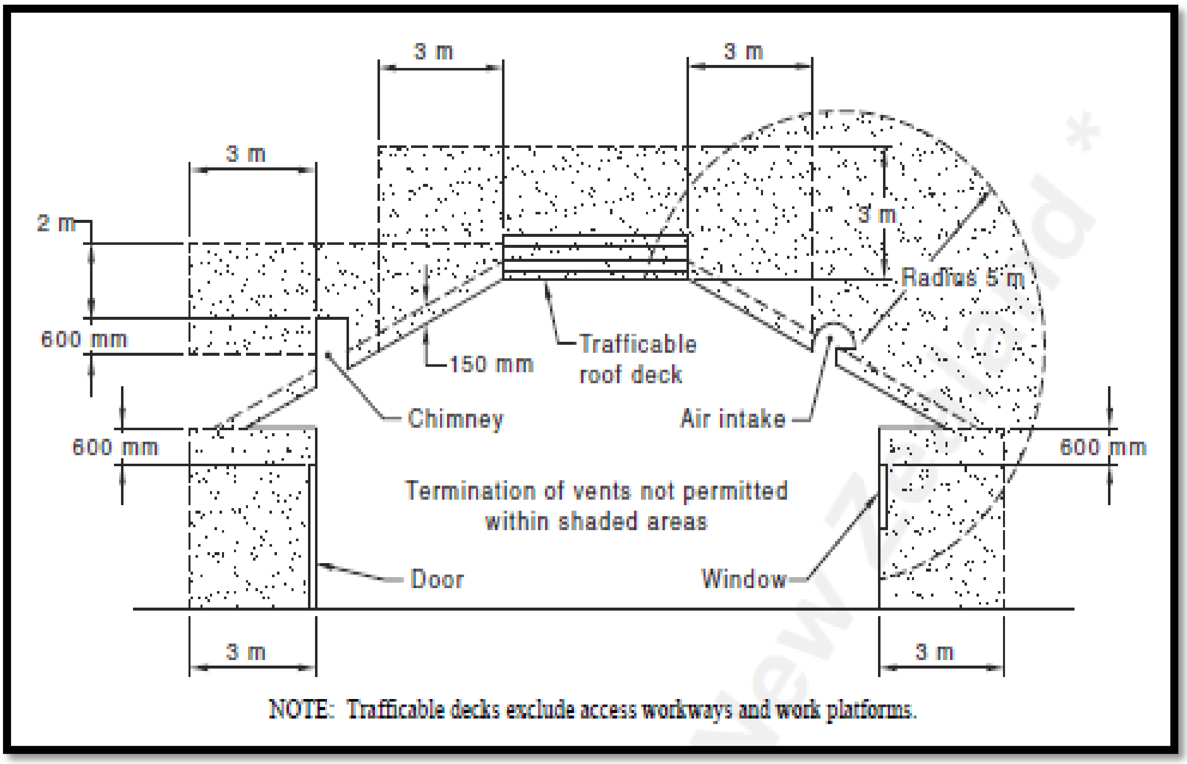


Figure above: AS/NZS3500.2:2018 fig 6.9.4 terminal vent exclusion zones

Floor wastes

A floor waste is not to be confused with a floor waste gully (FWG). They are not the same thing, are used in different circumstances, and are designed for different purposes.

FWGs are designed to receive wastes from sanitary fixtures (except a kitchen waste) before discharging to a stack or gully trap, whereas a floor waste does not receive waste from a fixture, only from water spillage or accidental overflow.

There are three different options for floor wastes depending on the situation:

- Have no trap and discharge to open air within the property boundary. It must discharge to a safe location and have a means to prevent the entry of birds and vermin.
- Be trapped and discharge 50mm above the grating of a gully trap with a vented pipe.
- Be trapped and discharge to the foul water plumbing system.

Floor wastes shall be installed with an accessible removeable grate and have a riser of not less than DN80 to finished surface level, except where the sole function of the floor waste is to dispose of water spillage and wash down water then a minimum DN50 outlet and riser may be used.

All fixtures discharging to a FWG must be located in the same room as the gully, except for tundishes for a HWC, or a self-priming device. FWGs shall not be installed in any refrigerated coolroom, air conditioning return air plenum or similar structure.

Waste pipes discharging to FWGs shall not be extended and trap vents shall not be installed on fixture discharge pipes.

Each fixture or fixture pair that is connected to a FWG shall be connected by a separate waste pipe at a grade of not less than 2.5% and with a length not exceeding the table below.

Waste fixture	Maximum length of waste pipe m		
	Connected to riser of floor waste gully		Connected to submerged inlet floor waste gully (see Figure 4.6.7.2)
	Fixture untrapped	Fixture trapped	Fixture trapped or untrapped
Bain-marie, sterilizer	1.2	2.5	Not allowed
Bar sink (commercial), glass-washing machine	1.2	2.5	Not allowed
Bar sink (domestic)	1.2	2.5	2.5
Basin, drinking fountain	Not permitted	2.5	2.5 (trapped only)
Bath, shower/bath	1.2	2.5	2.5
Bidet	1.2	2.5	Not applicable
Cleaners' sink	1.2	2.5	Not allowed
Clothes-washing machine	1.2	2.5	2.5
Laundry and ablution trough	1.2	2.5	2.5
Refrigerated cabinet	1.2	2.5	2.5
Shower	1.2	2.5	2.5
Tundish (see Clause 4.6.7.8)	10.0	10.0	10.0

NOTE: Floor waste gullies or similar traps directly connected to the drainage system and subjected to infrequent use shall be provided with an approved means of maintaining their water seals.

Figure above: AS/NZS3500.2:2018 table 4.6.7.2 discharge to FWGs

Note that some fixtures can enter the FWG untrapped with restrictions on the fixture waste pipe length.

The maximum length for an untrapped waste discharging into a FWG is 1.2m and a trapped waste 2.5m, and the maximum height of the riser from the water seal to the grate is 600mm. Note that kitchen sinks and dishwashers cannot connect into a FWG as food scraps may cause blockages. Washing machines may cause foaming so a suds arrestor may need to be added to the FWG.

With an ever-increasing number of multi-units being constructed in Auckland it is important that freewater from accidental overflow from sanitary fixtures and sanitary appliances be disposed of in ways that avoids loss of amenity or damage to household units or other property.

The acceptable solution E3/AS1 states that if a sanitary fixture is located where accidental overflow could damage an adjoining household unit, containment and a floor waste shall be provided.

Containment may be achieved by using impervious floor coverings which are continuous and coved, or joints sealed where they meet the wall.

There are alternative solutions to complying with E3.3.2 as seen in the MBIE Determination 2006/050 and Council will assess these requests on a case-by-case basis as alternative solutions. Most importantly, the water supply must not exceed the overflow capacity of the fixture for this type of alternative solution to be approved.

As a general rule, only rooms where the total sanitary fixture discharge units do not exceed 5 units would be assessed as minor variations.

The sanitary fixture model (with overflow capacity) and faucet model flow rates would need to show that the faucet water supply flow rate will not exceed the sanitary fixture overflow capacity. Where these are approved, they will be tested at the final inspection to ensure compliance.

Pressure attenuators (PAPA valve)

Pressure attenuators can be used in discharge stacks to counter the tendency for loss of trap water seals resulting from positive pressure pulses. They are an alternative solution to traditional relief venting and can be used in buildings up to 50 storeys.

Positive air pressure attenuators control a phenomenon called air transients (low volume but very fast-moving pockets of air in front or flowing water) which can either blow water seals or cause sewer gases to bubble through water seals. In either case sewer gases and associated pathogens can enter living spaces as a result of uncontrolled air transients. When these low volume but rapidly moving air transients begin to flow back through the stack, a bag in the attenuator is inflated. This instantly slows the air transient and dampens its effect, just as a water hammer arrestor does in a potable water plumbing system.

Pressure attenuators can be used on their own or mounted serially (stacked), depending on the demand. At least one unit is always fitted at the base of the stack between the exclusion zone and the first branch, because air transients are commonly created in this area, following the rapid fall of wastewater. For buildings greater than eight storeys, additional units must be fitted further up the stack.

- For buildings between 3 and 8 storeys, one pressure attenuator at the base of the stack.
- For buildings 9 to 15 storeys, one at the base of the stack plus one at mid-level.
- For buildings 6 to 25 storeys one at the base of the stack and one at intervals not exceeding 5 floors.
- For buildings 26 to 50 storeys two at the base of the stack, plus one at intervals not exceeding 3 floors up to level 25, then at intervals not exceeding 5 floors above that.

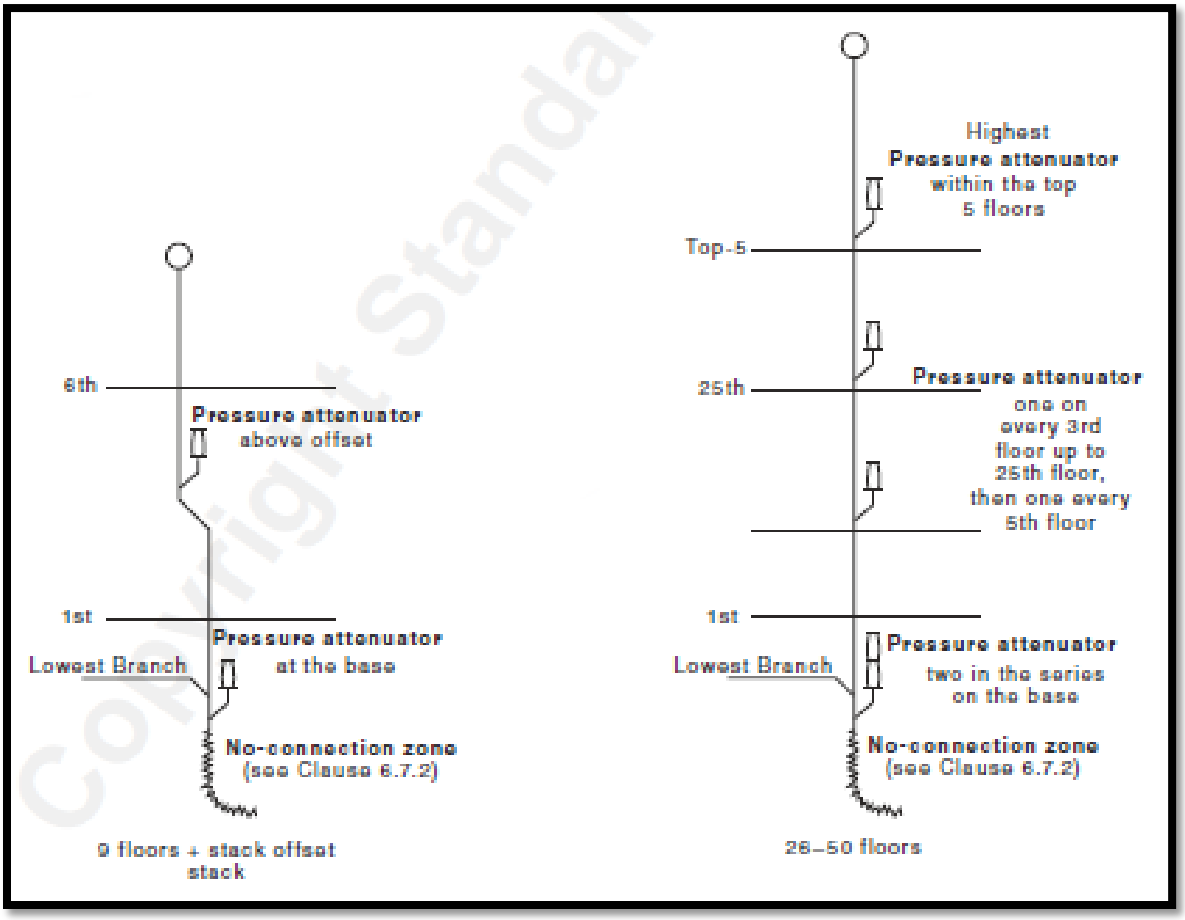


Figure above: AS/NZS3500.2:2018 fig 6.11.3 example of typical pressure attenuator installation

Air admittance valves (AAV)

AAVs may be used to ventilate traps, group vents, stacks vents and branch drains. They are not to be used to ventilate a main drain which requires a terminal vent (open vent).

Different capacity AAVs must be used for stack vents than those used for branch vents. Capacity is measured in litres per second (L/s). A *Studor Mini-Vent* has a capacity of 7.5 L/s and is suitable for all fixture and branch (group) vents up to 95 FUs.

However, this is only suitable for a stack vent up to 6 FUs with a Maxi-Vent (capacity 32L/s) being suitable for stacks up to 100 FUs.

If an AAV is used on a stack, always check the capacity of the fitting against the total loading of the stack.

An AAV shall not be used on a stack where the stack extends through more than 10 floors.

Where a stack also has a relief vent fitted, that vent must extend separately to open atmosphere.

Figure left: sample of 'Studor Mini-Vent' AAV

AAVs must be accessible for maintenance and located to allow adequate air to enter the valve. This means they must not be fitted inside a wall cavity but may be installed in a ceiling space provided there is access to the space.

It must be installed upright and protected from physical and mechanical damage. It shall be installed not more than 1m below the flood level of the fixture it is connected to (trap vent only).

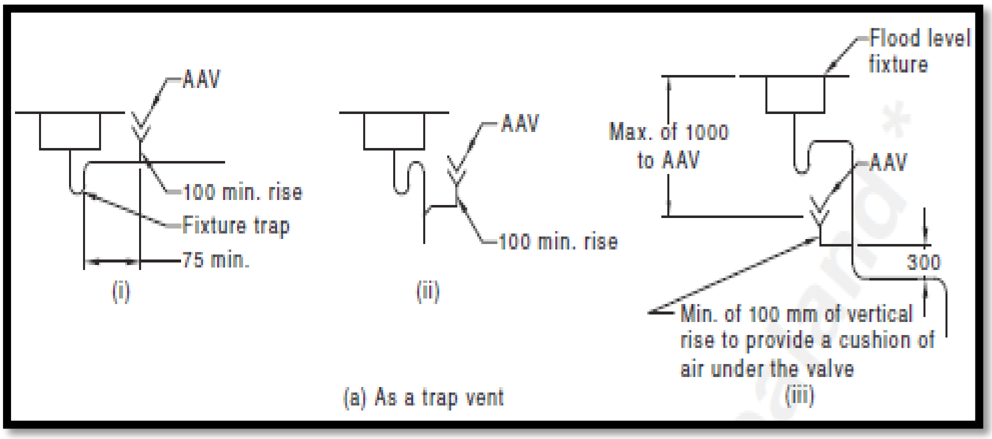


Figure above: AS/NZS3500.2:2018 fig 6.10.4 AAV usage as a trap vent

Stack de-aeration systems

All foul water systems are designed to control the effect of air flowing within pipework. Without controlling this airflow trap seals can be damaged, sucked by negative pressure or blown by positive pressure.

AAVs are used to manage negative pressure, and pressure attenuators to manage positive pressure. A *Reduced velocity aerator system* is non-mechanical with fittings to reduce the velocity of water running through the stack, and pressure relief vents at the base of the stack and at graded offsets.

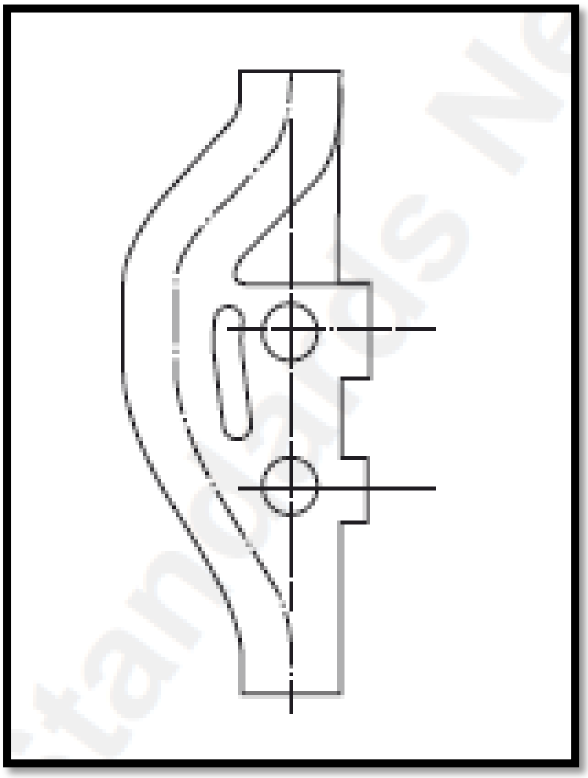


Figure left: AS/NZS3500.2:2018 fig 11.6.2 Typical aerator junction fitting

It is important that these double offset fittings are installed with the correct direction of flow. They are installed at every floor from which fixtures discharge into the stack but must not be more than 5m apart to control the velocity of wastewater even if no actual connections are made at these additional fittings. Because they are installed at maximum distances throughout the stack, soil and waste matter will not reach speeds which will compromise water seals and ensures the aeration of the stack by helping to maintain airflow through the centre of the stack.

Another part of the reduced velocity aerator system is the use of pressure-relief pipework to help manage hydraulic jump at the base of the stack, and the same problem occurs at the upper end of graded offsets. A de-aerator shall be installed at the base of the stack to provide a pressure relief bypass between the stack and the drain to which it is connected.

The pressure relief bypass pipe on a de-aerator shall run at least 2.5m from the centreline of the stack to the centre of the pressure relief bypass inlet junction. No connection shall be made into the bypass pipe. Connections shall not be made to the de-aerator pipe within 2.5m of the stack base.

Pressure relief bypass pipes for de-aerators shall run parallel to the base of the de-aerator with the invert of the pressure relief bypass pipe no lower than the centreline of the drain

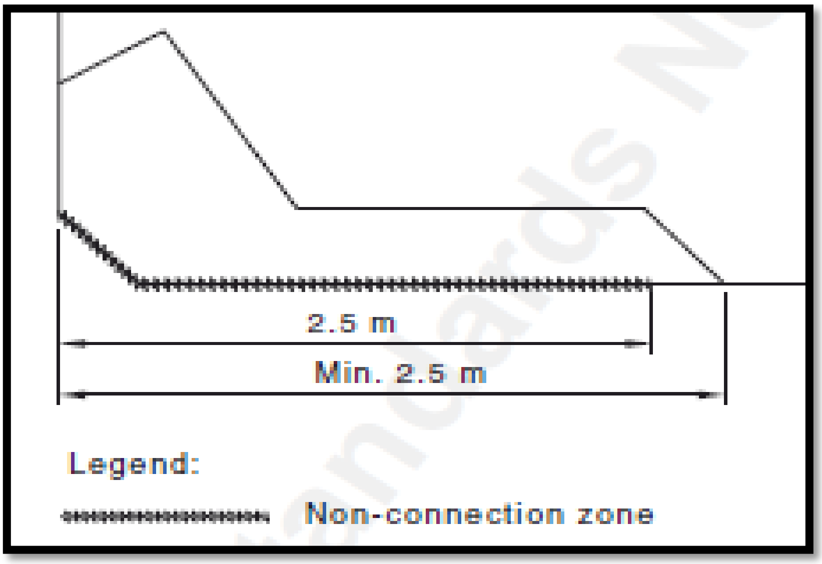


Figure above: AS/NZS 3500.2:2018 fig 11.9 De-aerator with pressure relief bypass pipe at the base of the stack

Pipe identification

All pipes installed in ducts, accessible ceilings or exposed in basements or plant rooms shall be clearly identified as per NZS 5807. The location of marking shall be at intervals of not more than 8m and preferably adjacent to branches, junctions, valves, walls and control points. Such markings shall be placed so that it can be easily seen from all approaches. The system used to identify the contents of the pipeline shall be maintained in good condition to be readily distinguishable.

Stormwater

Figures above: Checklist line item ‘Preline Storm water pipe gradients compliant’ and ‘Type’

Figure above: Checklist Parent line item ‘Preline Storm water pipework installed correctly-size, layout, joints primed/glued, supported, vent, lagging and label’

Note: When completing this parent line item, consideration must be given to cover all relevant child line items.

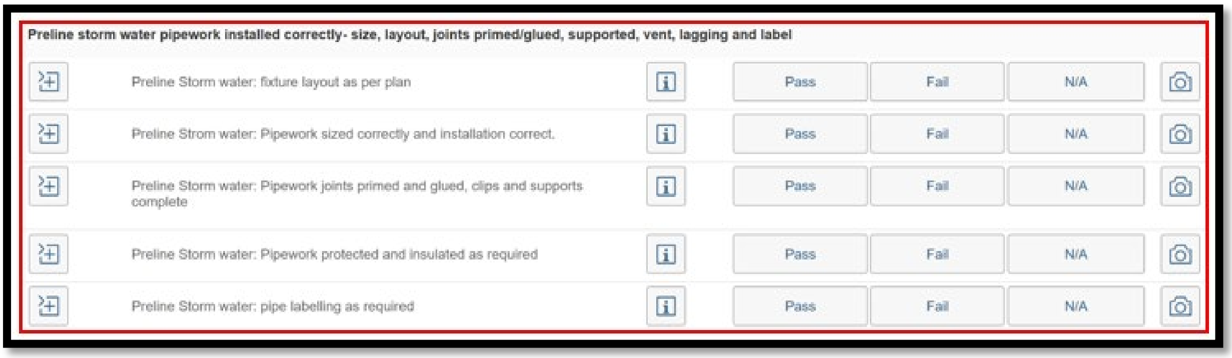


Figure above: Checklist Child line items

As with sanitary pipework, all stormwater fixture layout must be as per the approved plans. Pipes must be primed before being glued, supported the same spacings as per AS/NZS3500.2: 2018 table 10.2.1 shown in the Foul Water section of this module above.

Stormwater pipework is predominantly inspected on commercial sites. All pipes installed in ducts, accessible ceilings or exposed in basements or plant rooms shall be clearly identified as per NZS 5807. The location of marking shall be at intervals of not more than 8m and preferably adjacent to branches, junctions, valves, walls and control points. Such markings shall be placed so that it can be easily seen from all approaches. The system used to identify the contents of the pipeline shall be maintained in good condition to be readily distinguishable.

Pipework shall be protected and insulated as required for acoustic separation between multi-unit dwellings.

Siphonic downpipe system

Very large areas of roof as with sports stadiums, large factories, hospitals and warehouses, etc., can be drained using a sophisticated and fully engineered alternative drainage system called a siphonic or full-flow system. The system runs full bore with the pipes full of water, so if air is introduced to the system the water in the pipe will cease to flow full bore. This full-bore system allows for maximum drainage of water with smaller and fewer pipes.

In principle, siphonic drainage is a very simple process. Unlike traditional roof drainage, which is designed to flow part full, a siphonic system operates at full capacity, when water is sucked or syphoned from the roof down into the drain at high velocity.

The symphonic system is designed by professionals (usually engineers), so the system must be installed exactly as designed if it is to function efficiently and reliably. Three critical aspects of the design are:

- the rainheads
- diameters of the pipework (pipe sizing)
- pipework configuration (overall lengths, number and location of bends, velocity breaks, etc). A variety of materials are suitable for the pipework, including high-density polyethylene, polypropylene, polyvinylchloride, copper, steel and cast iron.

Whatever the pipework specified, it needs to be rigid, durable, and be able to withstand both positive pressures (up to 9m of water) and negative (vacuum) pressures (up to -9m of water). Because of the velocity of the water flow, substantially more bracketing and bracing is required at crucial points, and pipes to be insulated for acoustic requirement.

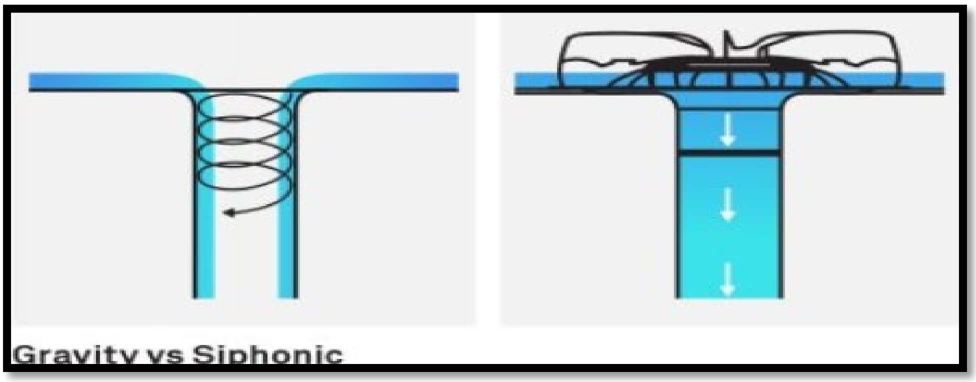


Figure above: sample of differentiation of conventional gravity system and siphonic system

Most siphonic systems have special features on the rain head (fins) which prevent the water from forming a vortex, directing the water directly down.

Water builds up in the gutter where it begins to cover the siphonic roof drains (manufactured with a baffle) which once covered with water, prevents air from being drawn into the system. If the baffle remains covered the system will begin to flow full bore.

A variety of materials are suitable for pipework, but it is essential that the material installed is the material specified by the designer, as even minor differences in frictional losses and internal diameter can affect the balance of the system and compromise its overall performance.

Depending on the material, joints will either be solvent-welded or heat-welded to ensure they are both watertight and airtight. All pipework must be pressure tested prior to commissioning. The designer will have calculated the balance between the velocity of the water and the frictional losses imposed by the material specified.

Full-flow rainwater systems are fully engineered systems. Therefore, it is essential to follow the design specifications without deviation. All details must be strictly adhered to if they are to function reliably, from the capacity of the boxed gutter and the precise location of rainwater heads, through to the points where pipes change direction, and changes in pipe diameter are specified.

If pipework cannot be installed as it has been designed, the inspection must fail and the designer must be contacted to have the design changed accordingly to regain the correct balance. For example, it is not uncommon to find that other services have been installed in the intended path of the pipework. Such variations to the original design can nearly always be accommodated, but it is essential that the designer of the system calculates and specifies changes, and not the installer.

Although pipework is generally smaller in diameter than for conventional ventilated gravity-fed systems, the forces applied by the high velocity of the rainwater flowing full-bore are much greater (typically as high as 6-7m/s) particularly at changes in direction, or changes in pipe diameter. Clipping is generally at closer intervals at a minimum spacing of 10 times the diameter of the pipe. Conventional clipping may not be suitable in all locations as some areas will require additional lateral support to resist movement and vibration that can occur due to high flow velocities. To assist the flow of water and reduce resistance, 45° bends and branches are used.

At some stages of flow pattern an unsatisfactory level of noise can be generated, so it may be necessary to insulate the pipework.

As with all internal gutters, provision must be made for overflow in the advent of the system becoming overloaded through blockages, etc. This is often done by installing another siphonic rain head at a higher level than the main one.

Postline inspection exemption

The Postline inspection has been identified as a low-risk inspection and one that can be removed from the list of required inspections in certain situations. The Postline inspection has traditionally been carried out to confirm the installation of wall linings providing bracing, fire and acoustic separations and wet area substrates.

An analysis of our pass-fail rate for this inspection in the residential sector is 11% indicating a high level of compliance on site with a number of those coming from deficiencies that would have negligible impact on the overall compliance of the bracing design that combined with our knowledge taken from witnessing the aftermath of the Christchurch earthquakes where the modern buildings typically performed well with regards to their bracing integrity. Also considered are discussions with Winstone Wallboards regarding the latent redundancy of the general wall linings (existing or new) throughout dwellings. These walls provide significant bracing yield yet are not factored into the bracing design so do provide a mitigation and additional capacity to ensure the building is adequately braced regardless of whether an inspection was passed or failed or exempted.

The intention to exempt Postline inspections is subject to the following assessment and conditions:

Types of IPL's NOT to be considered for an exemption (these require inspection).

- Any postlines that have fire and / or acoustic separations
- Any buildings above two stories

Conditions of the exemption

The exemption is at the inspector's discretion and is site specific and this decision should be made at the Preline inspection. The inspector is to ensure that the proposed exemption does not involve fire and / or acoustic separations and not more than two stories.

The inspector is to give consideration to the general quality of work along with a review of the inspection history when considering if the requirement for the Postline inspection can be removed. If there have been issues on site such as quality of workmanship or repeated failed inspections that would be grounds not to consider an exemption. The decision to exempt or require a Postline inspection must be identified in the inspection notes and the LBP is to be made aware of the following requirements if a decision for an exemption is made:

- No deviations from the approved plans and specified product's unless previously identified, discussed and approved by Council. If there are any changes from the approved design then the exemption is withdrawn and an inspection is required to assess the changes prior to the works being completed.
- A detailed record of works (ROW) must be provided as part of the CCC application, this must state the plasterboard product used has been installed as per the consented plans and manufacturer's specifications.

Template text for inspect

Having passed the Preline inspection and giving general consideration to the standard of works carried out on site along with the inspection wait times blowing out, it is considered appropriate to exempt the requirement for the Postline inspection as noted in the schedule of inspections. The following conditions apply:

- No deviations from the approved plans and specified products unless identified, discussed, and approved by Council. If there are any changes from the approved design, then this exemption is withdrawn, and an inspection is required to assess the changes prior to the works being started.
- A detailed record of works (ROW) must be provided as part of the CCC application and must state the plasterboard product used has been installed as per the consented plans and manufacturer's specifications.