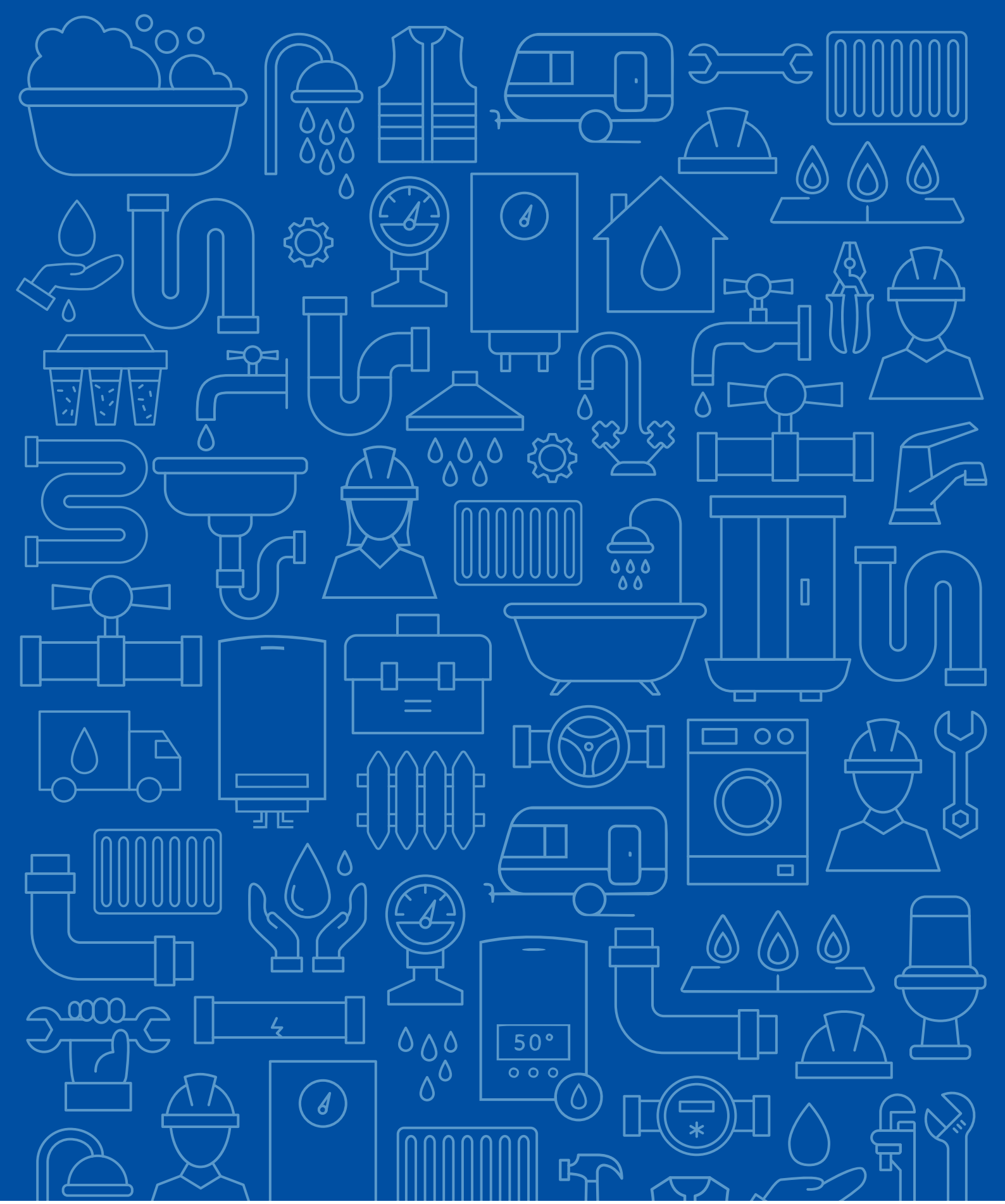


2026 Continuing Professional Development

Plumbers, Gasfitters and Drainlayers Board

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Introduction

Tēnā koutou katoa,

Welcome to the Plumbers Gasfitters and Drainlayers Board's 2026 Continuing Professional Development (CPD) course.

This year's CPD theme is 'Ethics and Integrity'. This focus reflects upcoming changes within the industry, including self-certification endorsements for plumbing and drainlaying and the Government's proposed introduction of a code of ethics for all practitioners.

Completing CPD as part of your licensing renewal requirements is about more than compliance. It's about being part of a profession that takes pride in safety, quality work, and technical expertise.

CPD topics this year cover changes to codes and regulation, tips on smarter trenching, seismic-resilient drainage systems, backflow and bidet seats, plus more. These topics have been shaped by last year's feedback, help line enquiries, and practitioner focus group input to ensure they are relevant to the work you do every day.

Following your participation in CPD, you will receive a short survey via email. We kindly ask that you take a few moments to complete this survey, as your feedback drives how we can best support you to succeed in your trade.

Ongoing practical guidance is available through our monthly *Info Brief* newsletter, the *Safe and Skilled* AI podcast and updates on codes and standards at ***www.pgdb.co.nz***. You can also contact us on our practitioner help line on 0800 743 262.

Thank you for the work you do every day to uphold the standards of your trade and to keep New Zealanders safe. We appreciate your ongoing commitment to professionalism and continued learning.



Ngā mihi
Aleyna Hall
Chief Executive

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Disclaimer

This material is provided for continuing professional development and general guidance only.
It summarises information from published standards, MBIE guidance, and manufacturer literature.
It does not constitute project-specific design, engineering, or compliance advice.
Practitioners should verify all requirements against the latest standards, product data, and local authority approvals.

01

Topic 01:
Industry updates

Constant changes are happening in our industry. This topic aims to provide a quick update on those changes:

- Updates regarding granny flats
- Overview of updates to AS/NZS 3500:2025
- Overview of updates to AS/NZS 5601.1.2022 AS/NZS 5601.2.2020 (Note: This covers off recent changes made to the GSMR in November 2025).

Written by:

Sam Wood
Plumbing and Gasfitting Consultant
S J Wood Consulting

Updates to granny flats



New Zealand has had a new building consent exemption for some small standalone dwellings, commonly referred to as granny flats. Since early 2026, New Zealand has introduced a building consent exemption for small standalone dwellings (commonly referred to as granny flats) of up to 70m².

In practice, this means a building consent is no longer required **where specific conditions are met**; including that the design remains simple and Building Code compliant, the work is carried out or supervised by licensed building professionals, and the homeowner notifies the local council before and after the work.

To qualify for the building consent exemption, the granny flat must be a **new, single-storey**, **standalone** dwelling of **70 square metres or less**. It must meet a range of design and construction limits intended to keep the work within a straightforward, low-risk scope. Those limits include matters such as material weights, setbacks, and other dimensional requirements. If those conditions are not met, the exemption falls away and a building consent will be required. Along with this there are some specific requirements around plumbing and drainage:

- must be designed and built to meet the Acceptable Solutions to comply with E1, G12 and G13
- maximum 30 fixture units
- no pumped systems inside the building
- the main drain is ≥ DN100 at 1:60 grade
- the branch drains are ≥ DN65 at 1:40 grade
- upstream vents are ≥ DN65
- no uncontrolled water heating (e.g. solar or wetbacks).

Drainage must connect to the Network Utility Operator (NUO). However, if there is no NUO or the existing has insufficient capacity, an onsite wastewater system can be used. These can be:

- existing onsite systems; or
- new onsite systems.

Both can be modified and built without a building consent.

AS/NZS 3500 series updates

The plumbing and drainage standards AS/NZS 3500:2025 parts 1–4 have been released. These are not yet cited in New Zealand so the updates could still be subject to modifications. There are a lot of updates so we have highlighted the key ones which could have an impact.

A summary of all the updates is in the preface of each document containing them.

AS/NZS 3500.1:2025

Atmospheric vacuum breakers

The updates in relation to Atmospheric vacuum breakers (AVB) include:

- Clause 4.4.1 – AVBs have been reclassified from “non-testable devices” to “registered testable devices”
- Clause 4.6 – Multiple updates around the installation of AVBs.

Registered or testable backflow prevention device	Cross-connection hazard rating	Protection against back-pressure	Protection against back-siphonage
Registered testable devices			
Registered break tank (RBT)	High/medium/low	Yes	Yes
Registered air gap (RAG)	High/medium/low	Yes	Yes
Reduced pressure zone device (RPZD)[a]	High/medium/low	Yes	Yes
Reduced pressure detector assembly (RPDA)[a]	High/medium/low	Yes	Yes
Double-check valve assembly (DCV)[a]	Medium/low	Yes	Yes
Double-check detector assembly (DCDA)[a]	Medium/low	Yes	Yes
Spill resistant pressure type vacuum breaker (SPVB)[a]	High/medium/low	No	Yes
Pressure type vacuum breaker (PVB)[a]	High/medium/low	No	Yes
Atmospheric vacuum breaker (AVB)[b]	High/medium/low	No	Yes

Figure 1. ***AS/NZS 3500.1:2025 Table 4.4.1***

Miscellaneous devices

A new clause 5.20 has been introduced about miscellaneous devices and appliances. This provides a number of requirements for devices connected to the drinking water supply, such as:

- pipework size
- backflow protection
- isolation
- pressure
- means of disconnection.

This is relevant for appliances such as coffee machines which are not detailed in AS/NZS 3500.

Isolation valves

Clause 5.4 requires isolation valves to be installed immediately before each flexible hose assembly that is connected to a mixer valve, tap outlet or cistern. This is already standard practice in Australia.

Rainwater supply

A New Zealand specific section on rainwater supply systems is now included. Prior to the addition of this section 16 New Zealand did not have any standard for the installation of rainwater tanks. The section includes:

- **Clause 16.2.1.1** – The design and installation of rainwater tanks
- **Clause 16.2.2** – Access to the tanks (e.g. for maintenance, cleaning and repairs)
- **Clause 16.2.3** – Placement of tanks shall not be below sanitary plumbing of pipes containing non-potable water
- **Clause 16.3.1** – Tank material requirements
- **Clause 16.3.2** – Tank overflow requirements
- **Clause 16.5** – Identification of pipework and outlets (e.g. if there are multiple water supplies the pipework is marked RAINWATER)
- **Clause 16.7** – Testing, flushing and commissioning the system.

AS/NZS 3500.2:2025

Tundishes

Clause 13.21 says that tundishes can be connected to a disconnector gully. Tundishes must be accessible and securely fixed to prevent movement.

Waterless urinals

There are several new or amended clauses about waterless urinals. These include:

- **Installation** (Clause 13.24.2.1): Waterless wall-hung urinals must connect directly to a soil stack or drain through an individual discharge pipe not smaller than DN65, graded at no less than 5% toward the stack or common discharge pipe.
- **Pipe layout** (Clause 13.24.2.3.3): The graded section between the sealing device and the vertical dropper must be no longer than 300mm, and the dropper must be vertical or inclined no more than 45° from vertical (see Figures 13.24.2.3.4(C) & (D)).



Figure 2. ***Example of waterless urinals***

- **Common discharge pipes** (Clause 13.24.2.3.4): Connect using 45° junctions with entry levels 20°–45° above horizontal. The pipe must be ≥ DN65, or DN100 where WC pans connect upstream. Provide 1 fixture unit of wastewater per urinal or install an approved flushing device if flow is insufficient. (Note 1: Grade 3.35%–6%; Note 2: See Figures 13.24.2.3.4(A)–(G)).

- **Access and conversions** (Clauses 13.24.2.3.5 & 13.24.3): Provide inspection openings on both individual and common discharge pipes. Urinals cannot be converted to waterless models unless the installation fully meets Clauses 13.24.2.1 and 13.24.2.3.

Miscellaneous discharges to sanitary plumbing and drainage systems

There is a new Clause 13.28 for miscellaneous discharges to sanitary plumbing and drainage systems. This includes how it can be connected:

- through a direct connection with a trap; or
- a tundish.

AS/NZS 3500.3:2025

Eave and gutter systems

A new clause 3.5.3 deals with the design procedure for overflows. It references Appendix F which has now been made normative (mandatory).

Rainwater harvesting systems

A New Zealand applicable section for rainwater harvesting has been added. This section complements Section 16 in AS/NZS 3500.1:2025 and mirrors many of the requirements. Additionally:

- 11.3 outlines details about debris screens:
  - **Clause 11.3.2** – Debris screens (e.g., leaf diverters) shall be corrosion-resistant and have openings no larger than 1mm (this is to keep mosquitos out)
  - **Clause 11.3.3** – All rainwater shall pass through a debris screen before it is stored in a rainwater tank
  - **Clause 11.3.4** – Downpipes shall be not less than 30mm above any screen
  - **Clause 11.3.5** – Debris screens must be accessible for removal and maintenance
- 11.4 provides details on charged rainwater harvesting systems:
  - **Clause 11.4.3** requires the minimum diameter of rainwater harvesting systems to be DN100
  - **Clause 11.4.4** requires charged systems to have a minimum fall of 1:100 towards the flush point
  - **Clause 11.4.5** requires a sealed inspection opening to be provided at several points
  - **Clause 11.4.6** requires branch connections to a charged downpipe must be swept
- Clause 11.5.1 provides details about the required height of the tank inlet in relation to the roof gutter outlet or debris screen.

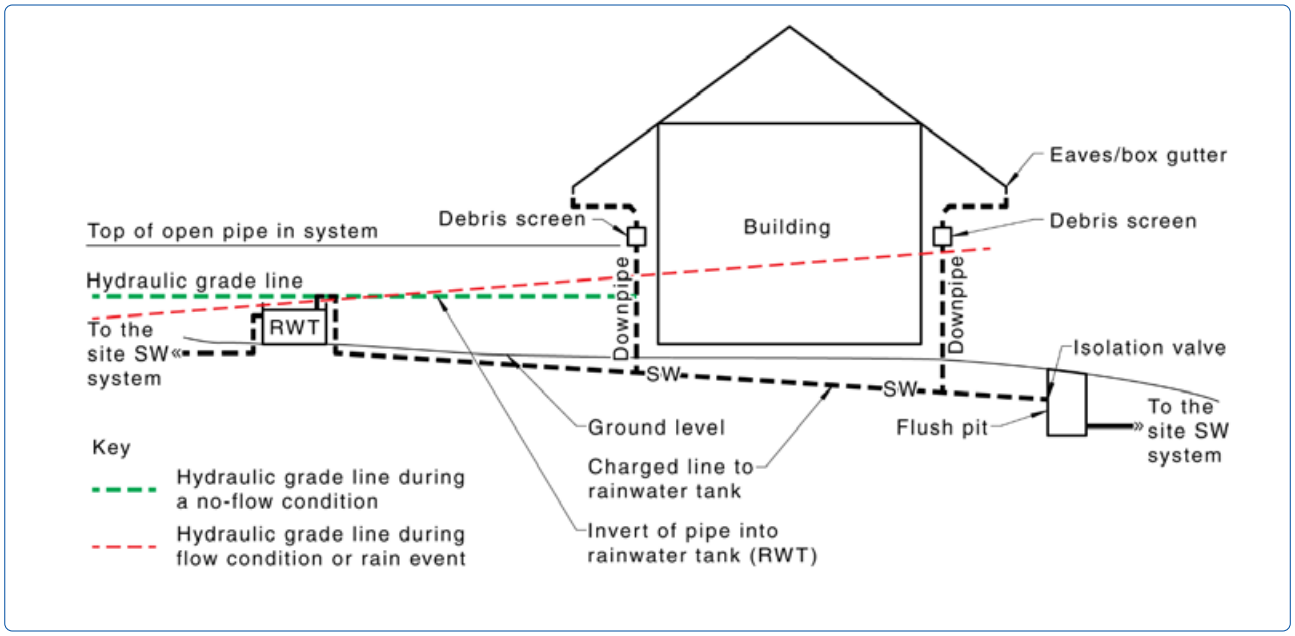


Figure 3. ***Hydraulic grade line***

Appendix F

Appendix F, previously informative only, has now been made a mandatory requirement going from informative to normative.

There is a significant update to Appendix F for overflow design for eaves gutters, outlining multiple details for their design. This includes:

- procedures for roof catchments up to 400m²
- a design overflow volume calculation
- table F1 has been updated
- updated imagery to show roof gutter (spouting) installations.

AS/NZS 3500.4:2025

Clause 10.10.2 has been updated to include a similar clause to AS/NZS 3500.1 stating that isolating valves must be installed immediately before each flexible hose assembly connected to a mixer valve or tap outlet.

AS/NZS 5601 series updates

AS/NZS 5601.1:2022

The Government recently published the Gas (Safety and Measurement) Amendment Regulations 2025, which amends the 2010 regulations.

This piece of law determines which version (i.e. year) of AS/NZS5601 gasfitters must use for gas installation work. It does this by 'citing' or listing the official standards that must be used for compliance (see Schedule 1 of the regulations).

The amended Gas (Safety and Measurement) Regulations 2010 came into effect on 13 November 2025.

The key changes are:

AS/NZS 5601.2

The currently cited version, AS/NZS 5601.2: 2013 unamended, changes to:

- AS/NZS 5601.2: 2020 Gas installations – Part 2: LP Gas installations in caravans and boats for non-propulsive purposes, including Amendments 1 and 2.

AS/NZS 5601.1

The currently cited version, AS/NZS 5601.1: 2013 unamended, changes to:

- AS/NZS 5601.1: 2013 Gas installations – Part 1: General installations, including Amendments 1, 2, 3, and 4; OR
- AS/NZS 5601.1:2022 Gas installations—Part 1: General installations, including Amendments 1 and 2.

This means that gasfitters can choose which of the newly cited versions of AS/NZS 5601.1 they wish to use.

However, the certifying gasfitter must choose to follow one version of the standard for the whole installation, or part installation, that is being carried out. **The work that you do, or supervise, cannot follow a mix of clauses from both versions of the standard.**

Some of the key changes for AS/NZS5601.1 are:

- multilayer gas pipe can still be installed above ground external to a building under the 2013 version of the standard. It cannot be installed above ground external to a building under the 2022 version of the standard
- allows jointing compound to be applied to the face of a copper flare, olive, and galvanised steel mac union. This jointing compound can still not be used to compensate for ill-fitting joints
- this also allows jointing compound to be applied to a compression joint
- new requirement for a regulator to be fitted to an endorsed appliance as well as a certified appliance.

In all cases, if you choose to apply jointing compound, it must be a proper jointing compound that is non-setting. A setting thread sealant or silicone cannot be used as the standard does not allow it.

Some key changes for AS/NZS5601.2 are:

- allows jointing compound to be applied to a compression joint
- this allows European and North American appliances to run at the slightly higher pressures they need
- allows jointing compound to be applied to the face of a copper flare, olive, and galvanised steel mac union. This jointing compound can still not be used to compensate for ill-fitting joints
- a gas compliance plate is not required in New Zealand. In New Zealand a person who performs gasfitting work is required to issue a CoC for general and high-risk work, a GSC for all gasfitting work, and to place a record of the CoC on the WorkSafe Electricity and Gas High Risk Database for all high-risk work.

Existing installations

The amendments do not require old gas installations and appliances to be upgraded. The amendment regulations allow current installations to continue to exist and be repaired so long as they are not unsafe. There is no time limit for this.

If you are modifying, adding to or altering an existing installation, you can choose to use either of the new standards from 13 November 2025. There is no requirement to upgrade the current parts of the existing installation to the new standard. Only the parts that you change need to be to the new standards.

If construction begins after 12 November 2026, the work you do needs to comply with one of the new standards.

If work on an installation is started after 13 November 2025, using the old version of the standard, it must be completed by 12 November 2026. If the installation is unfinished by that date, complete a Certificate of Compliance for the work completed up to that date. The rest of the work must comply with the new version of the standard.

If construction on these types of work began before 13 November 2025, the old version of the standard may continue to be used, up to the point that the installation is complete. There is no time limit on completion for using the old standard in this case.

From 13 November 2025 onwards, the newly cited version of the standard can be used. Work that has already been done can be modified to comply with the new standard.

Construction, in this context, also includes the design phase. This means work can be done to the old standard if the quote or tendering process is already underway.

Repairs

There is an allowance related to the repair or maintenance of an existing installation – the 2013 unamended version of the standard can continue to be used for any repair work. The work must be a genuine repair of the existing installation. If the repair work changes to include any alterations or additions, then it must comply with one of the newly cited standards.

Unsafe Installations

If something is unsafe, all the usual requirements apply. You can't leave the unsafe part connected to the gas supply if you have done work on the installation and if the customer doesn't want you to repair it. If the customer does give you permission to repair the unsafe part, then the repair can comply with the old version of the standard. Remember, if you haven't performed gasfitting on the installation, you have no legal authority to disconnect the installation if the customer doesn't give permission for a repair. So, if you

go for a quote and the customer doesn't like your price, then you must leave the installation alone. The best bet in this situation is to notify the customer of the danger, using the forms on the WorkSafe website.

New installations

A new installation is one where a gas installation was not already present.

From 13 November 2025 you can choose to use one of the new standards when installing a new gas installation.

All new gas installations, where construction begins after 12 November 2026, must comply with one of the new standards.

If the construction of a new or part installation is started in line with the old version of the standard after 13 November 2025, it must be completed by 12 November 2026. If the installation is unfinished by that date, complete a Certificate of Compliance for the work completed up to that date. The rest of the work must comply with the new version of the standard.

The older version of the standard can continue to be used for new installations where construction began before 13 November 2025, up until the point that the installation is complete. There is no time limit on completion for using the old standard in this case.

From 13 November 2025 onwards, the new version of the standard can be used. Work that has already been done can be modified to comply with the new standard.

Construction, in this context, also includes the design phase. This means it is possible to undertake work to the old standard if the quote/tendering process is already underway.

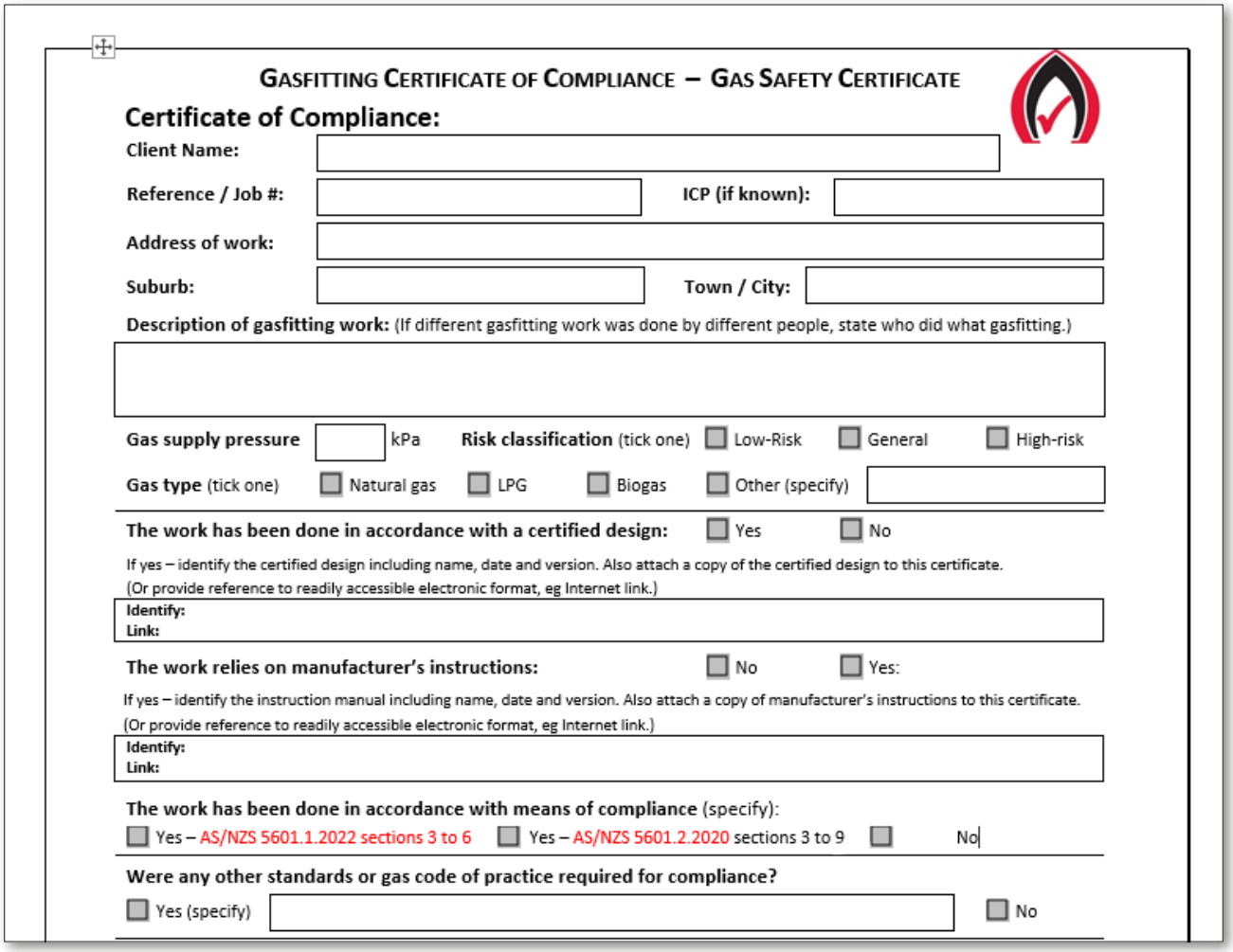
From 13 November 2025 other gasfitting work also changes:

- the checks you do on an appliance or fitting after a repair, modification, and adjustment can follow NZS 5266:2014 Safety of gas appliances
- how you verify an installation that is hired or leased as well as an installation that has been disconnected for 6 months or more can follow NZS 5255:2014 Safety verification of existing gas installations, including Amendment 1.

You can use the old versions of the standards up until 12 November 2026. From this date, you must use the new cited standards.

NOTE:

Make sure you identify on the gas certificate which version of the standard you are using, see example over the page in red.



GASFITTING CERTIFICATE OF COMPLIANCE – GAS SAFETY CERTIFICATE

Certificate of Compliance:

Client Name:

Reference / Job #: **ICP (if known):**

Address of work:

Suburb: **Town / City:**

Description of gasfitting work: (If different gasfitting work was done by different people, state who did what gasfitting.)

Gas supply pressure kPa **Risk classification** (tick one) ☐ Low-Risk ☐ General ☐ High-risk

Gas type (tick one) ☐ Natural gas ☐ LPG ☐ Biogas ☐ Other (specify)

The work has been done in accordance with a certified design: ☐ Yes ☐ No

If yes – identify the certified design including name, date and version. Also attach a copy of the certified design to this certificate.
(Or provide reference to readily accessible electronic format, eg Internet link.)

Identify:
Link:

The work relies on manufacturer's instructions: ☐ No ☐ Yes:

If yes – identify the instruction manual including name, date and version. Also attach a copy of manufacturer's instructions to this certificate.
(Or provide reference to readily accessible electronic format, eg Internet link.)

Identify:
Link:

The work has been done in accordance with means of compliance (specify):

☐ Yes – AS/NZS 5601.1.2022 sections 3 to 6 ☐ Yes – AS/NZS 5601.2.2020 sections 3 to 9 ☐ No

Were any other standards or gas code of practice required for compliance?

☐ Yes (specify) ☐ No

Figure 4. ***Example of a Gasfitting Certificate of Compliance with both versions of standards referenced***

Summary

The changes made to AS/NZS5601 may be confusing in allowing the practitioner to choose either version of two standards. You should note on your gas certificates which version you have chosen to use.

You have until November 2026 for the changes to become permanent; use this time well to update your processes for the adoption of the cited versions of AS/NZS5601.

Conclusion

The plumbing, gasfitting and drainlaying industry continues to evolve, and staying up to date means staying professional. This topic covers the latest changes that matter on the tools — from new rules for granny flats and updates to the AS/NZS 3500 and 5601 standards. These updates are about more than paperwork; they reflect a smarter, safer, and more consistent way of working that helps protect the people we serve and the reputation of our trade. By keeping pace with these developments, we maintain the high standards and trust that define what it means to be a licensed professional in New Zealand's building industry.

Ethics and integrity



Our industry is always changing, and keeping up with those changes is part of your professional responsibility. Updates to granny flat rules and to standards like AS/NZS 3500 and AS/NZS 5601 give clearer guidance on how to carry out safe, compliant work. Ethical practice means understanding what's changed and applying those requirements properly on the job.

When updates allow choice, such as which version of a gas standard to use during a transition period, professionalism shows in making a clear decision, following one standard consistently, recording it correctly, and explaining it to the customer. By staying informed and applying updates carefully, plumbers, gasfitters and drainlayers help protect public safety, build customer trust, and uphold the reputation of the trade.

02

Topic 02:
Seismic-resilient drainage systems

Drainage systems in New Zealand must cope with a range of ground movements — from gradual seasonal changes in reactive soils, to sudden displacements caused by seismic activity. Both conditions can place significant strain on buried drains, fittings, and penetrations.

Designing for resilience means allowing controlled movement within the system so pipes remain watertight, comply with the standards, and continue operating after the ground shifts. Flexible joints, oversized penetrations, appropriate restraint, and coordination with structural and geotechnical engineers form the foundation of seismically resilient drainage installations

The following sections outline how these principles apply in practice.

Written by:

Jordan Ross — Endeavour Consulting Ltd
Collaborators: Paul Trentini - Storm Plastics (Australia / New Zealand), DLM Wallace Ltd

Key learning objectives

After completing this topic, practitioners will:

- understand how seismic activity, reactive soils, and thermal expansion influence drainage performance
- describe the difference between Serviceability Limit State (SLS) and Ultimate Limit State (ULS) performance
- recognise how building Importance Levels (IL) influence seismic performance expectations
- identify appropriate locations and applications for flexible and articulated drainage joints, including seismic expansion joints
- understand installation principles for penetration detailing, restraint, and allowances for movement
- outline inspection and reinstatement considerations following seismic events.

Serviceability and Ultimate Limit State performance

Seismic design in New Zealand is commonly considered across two performance levels under NZS 1170.

Serviceability Limit State (SLS)

SLS represents smaller, more frequent earthquake events. At this level, buildings and services are generally expected to remain usable with limited damage.

For drainage systems, SLS performance typically relates to:

- maintaining alignment and gradient
- remaining watertight at penetrations and joints
- avoiding joint separation
- preserving self-cleansing flow.

Ultimate Limit State (ULS)

ULS represents larger, less frequent design-level earthquake events. At this level, the primary objective is life safety and prevention of collapse.

For drainage systems, ULS performance typically relates to:

- avoiding falling components or failures that create secondary hazards
- maintaining integrity of supports and restraints
- reducing the likelihood of rupture at slab penetrations or articulation points.

Seismically resilient detailing typically include: flexible joints, oversized penetrations, and appropriate restraint. It supports performance at both SLS and ULS levels by allowing controlled movement and reducing stress concentrations.

Building Importance Level considerations

Seismic design actions are influenced by a building's Importance Level under NZS 1170.0 and NZS 1170.5. Importance Levels reflect the consequences of failure and the expected function of a building following a seismic event.

Importance Level	Typical Examples
IL1	Minor storage sheds, farm buildings
IL2	Most residential and commercial buildings
IL3	Schools, theatres, large assembly buildings, or buildings containing hazardous materials
IL4	Hospitals, emergency facilities, fire stations, civil defence centres

Figure 1. ***Building importance level, typical examples.***

Higher Importance Levels generally involve higher performance expectations and reliability targets for the building and its systems.

While AS/NZS 3500.2 does not directly vary drainage design based on Importance Level, designers may consider enhanced detailing for higher Importance Level buildings, such as:

- increased articulation at building interfaces
- seismic restraints for suspended pipework
- redundancy in critical drainage pathways where relevant
- clear post-event inspection and reinstatement planning.

Coordination with the structural engineer and project team is critical where higher Importance Levels apply.

Expansive soils and their effect on drainage systems

Most building projects in New Zealand involve a geotechnical assessment to confirm foundation suitability. Soil reactivity and predicted surface movement are key considerations.

Expansive (reactive) soils expand when wet and shrink when dry. This cyclical movement can apply pressure to underground pipework similar to seismic displacement.

If drains are rigidly installed through slabs or foundations, movement can result in:

- cracking
- shearing at connections
- loss of grade
- joint separation.

AS/NZS 3500.2 Appendix G provides informative guidance on soil classifications, referencing movement values from AS 2870:2011.

Geotechnical engineers in New Zealand commonly reference NZS 1170.5 for seismic subsoil classifications. Although the classification systems differ, consultation with the project engineers can help interpret predicted movement and determine whether articulated or flexible joints may be appropriate.

Soil classification	Soil foundation	Expected surface movement (mm)
A	Most sand and rock sites with little or no ground movement from moisture changes	0–10
S	Slightly reactive clay sites, which may experience only slight ground movement from moisture changes	10–20
M	Moderately reactive clay sites, which may experience moderate ground movement from moisture changes	20–40
H1	Highly reactive clay sites, which may experience high ground movement from moisture changes	41–60
H2	Very highly reactive clay sites, which may experience very high ground movement from moisture changes	61–75
E	Extremely reactive sites, which may experience extreme ground movement from moisture changes	> 75
P	Problem site – requires geotechnical investigation Refer to Clause G.1 in ASNZS 3500.2 for more information on Class P sites	Variable

Figure 2. ***ASNZS 3500.2:2021 Appendix G, Table G.1***

Designing for soil movement using flexible joints, sleeves, and bedding systems ensures drains can tolerate both longterm soil change and short, sudden seismic displacement.

Table SP 01 - SOIL CLASSIFICATION, DIFFERENTIAL MOVEMENT, GRADE, ANGLE, JOINTS LOCATION & DRAWING No'S. CHAR

AS2870-2011 SOIL CLASSIFICATION	ON SITE SOIL CONDITIONS	DIFFERENTIAL MOVEMENT	SEWER & Stormwater GRADE	SWIVEL * (50mm Expansion)	SWIVEL/COMBO * (100mm Expansion)	EXPANDA JOINTS *	CREEP SLOPE SITES	DRAWING NUMBER
A	Most Sand & Rock sites	0 - 10mm	1:60 Minimum	Not necessary	Not necessary	Not necessary	These are termed P sites and are referred to in Drawing SP 105	N/a
S	Slightly reactive Soils	10 - 20mm						N/a
M	Moderatively reactive soils	20 - 40mm						SP 100 & SP 101
H1	Highly reactive soils	40 - 60mm	1:40 Minimum	As per AS3500.5 using 2 units outside and an Expansion Joint at every riser Not applicable to suspended sub-floors	As necessary using either or both Bend or Straight units ....unless suspended from slab	At Junctions within 1 mtr of internal building footprint and every 6 mtrs. As per Differential Movement See AS2032-2006 Clause 6.4.2.2-4 for suspension requirements		SP 102
H2	Very highly reactive soils	60 - 75mm						SP 102A
E	Extremely reactive soils	75 + mm						SP 102A
P	Soils affected by Abnormal moisture and conditions	From.. 20 + mm	As per Differential Movement					SP 105A

NOTE: Engineer or local Authority details take precedence over this chart

To be read in conjunction with Storm Plastics drawings shown.

Figure 3. ***Table SP 01 from the Storm Plastics Installations Guidelines***

Design codes and standards

The following standards and guidelines outline best practice for drainage in reactive or seismic conditions:

AS/NZS 3500.2:2021 – Sanitary plumbing and drainage
(includes new guidance on flexible joints and connection detailing)

AS/NZS 2032:2006 – Installation of PVC pipe systems
(allows for expansion and contraction due to thermal movement)

MBIE Building Performance Section A – Figures S14 & S15
(details seismic pipe penetration and sleeve configurations)

NZS 3604:2011 – Timber-framed buildings
(covers restraint and bracing of plumbing and services)

Storm Plastics Installation Guidelines (2018 & 2025)
(product-specific recommendations for swivel and expansion joints)

Practitioners should refer to the current edition of the applicable standard and any project-specific specifications.

Installation principles

Effective seismic and thermal resilience relies on allowing controlled movement within the system and avoiding stress concentrations.

Allow for thermal movement (AS/NZS 2032)

Provision should be made for thermal expansion in accordance with AS/NZS 2032:2006.

Expansion joints are typically installed:

- at intervals not exceeding 6m for pipes outside direct sunlight
- at intervals not exceeding 4m where pipes are exposed to heat, sunlight, or roof spaces.

For vertical DWV stacks and discharge pipes, expansion joints are generally positioned:

- on each floor directly above the highest branch connection
- at the base of stacks
- at the end of long graded connections.

Thermal expansion can be achieved using rubber ring jointed connections that allow for the predicted movement.

Provide movement capacity at building interfaces

Drainage systems should allow for differential movement between the building and surrounding ground. This is commonly achieved using:

- oversized sleeves through slabs or foundations
- flexible seals or compressible filler
- articulation joints near penetrations.

Maintain appropriate grades

Designers/Installers may consider steeper grades (for example 1:40) in reactive or seismic environments to help maintain self-cleansing performance if minor displacement occurs.

Avoid under-slab drains where practical

AS/NZS 3500.2 recognises accessibility and maintenance considerations. External routing can reduce stress at slab penetrations and improve long-term serviceability where practical.

Early coordination with structural and civil engineers supports alignment with the building's overall seismic performance strategy.

Pipe penetration details – MBIE Figures S14 and S15

Where pipes pass through foundations or slabs, Ministry of Business, Innovation and Employment (MBIE) guidance recommends flexible detailing that allows independent movement between the structure and the pipe.

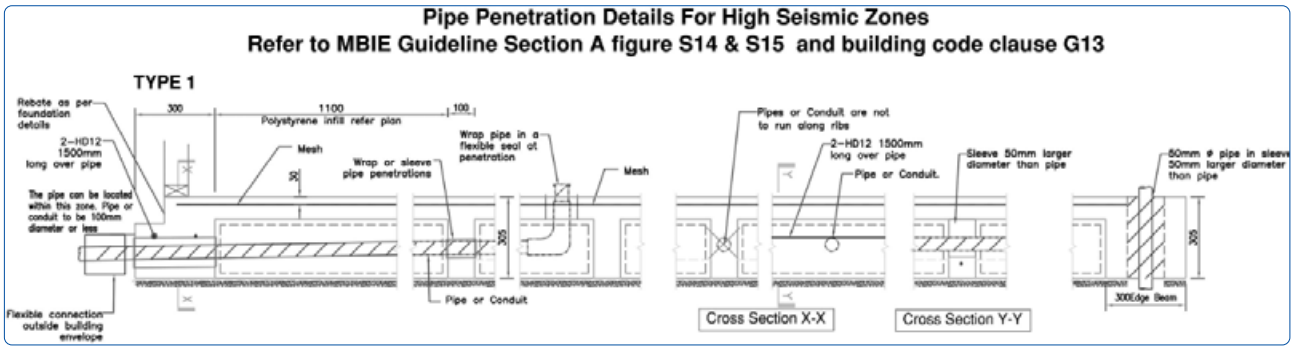


Figure 4. ***MBIE figures S14 and S15, Pipe penetration details for seismic zones***

Essential details:

- oversized sleeves
- flexible seals or compressible filler between the pipe and the sleeve
- articulation joint or flexible connection located immediately outside of the building edge.

MBIE Figures S14 and S15 illustrate sleeves oversized by approximately 125mm greater than the pipe outside diameter for typical building service penetrations. The required clearance should be confirmed based on pipe diameter, predicted movement, and project requirements.

These measures reduce stress concentration at structural interfaces and improve resilience during both gradual soil movement and seismic displacement.

Final detailing should be confirmed with the project structural engineer and local authority requirements.

Flexible pipe joints and materials

Mechanical joints provide controlled articulation and telescopic movement. When correctly installed, they maintain alignment and watertightness even when ground or structural movement occurs.

Flexible joints are commonly used to manage:

- differential movement between slab and ground
- reactive soil movement
- thermal expansion
- minor seismic displacement.

Joint type	Axial movement	Angular deflection	Typical application
Telescopic	50–240mm	0°	Long straight runs
Swivel (SJ10015)	±25mm	15°	At slab exits/risers
Combo/Expanda	Up to 100mm	15°	External drains/risers

Figure 5. ***Typical expanda joint types***

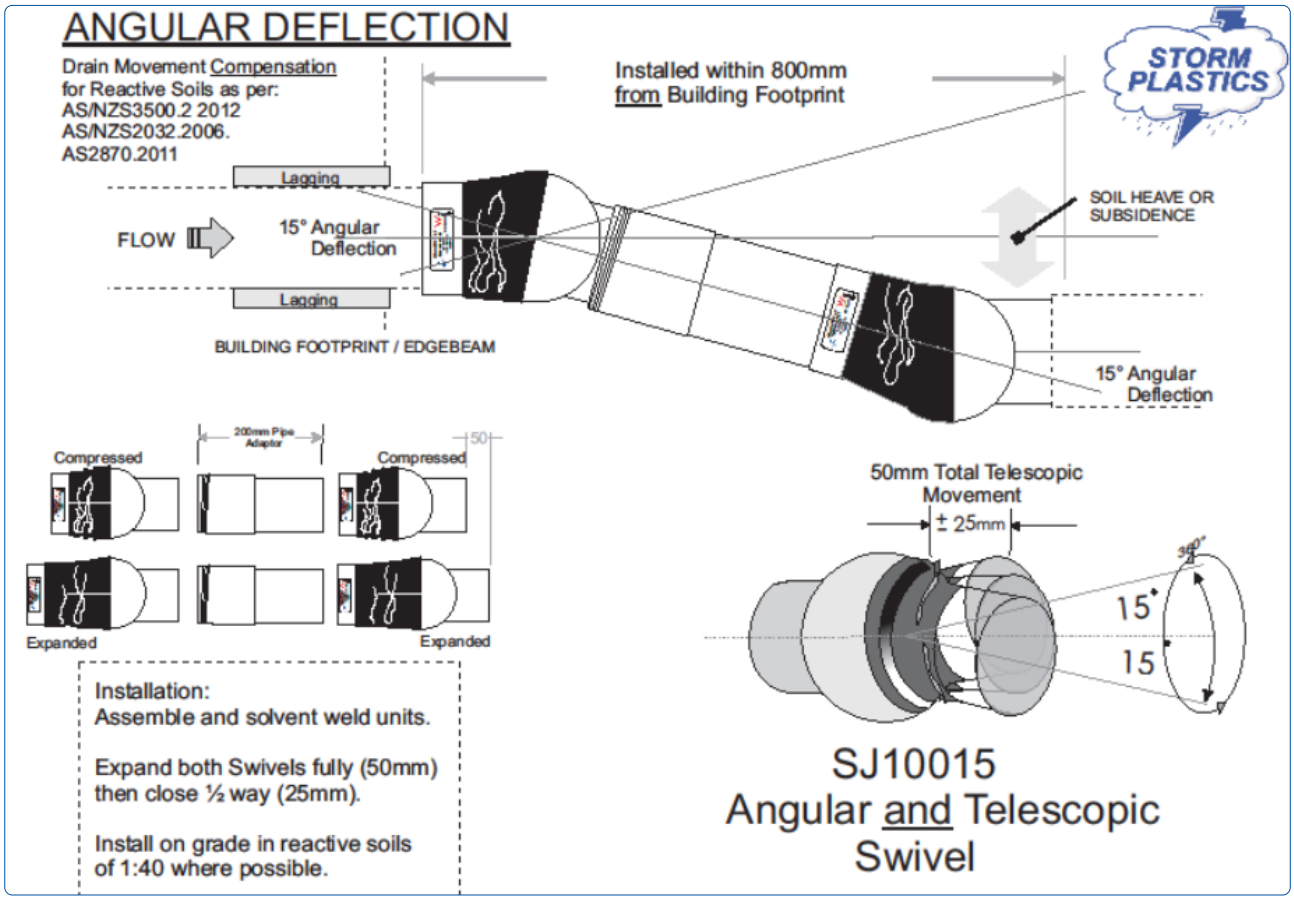


Figure 6. ***Example of stormplastics combo/expanda joints to allow drain movement compensation for reactive soils.***

Installation tips

- Place flexible joint immediately outside of slab penetration or where movement is anticipated.
- Keep joints clean and free sliding by covering with plastic prior to backfilling.
- Confirm telescopic position is correct before handover.
- Avoid fixing points directly beside joints – allow for controlled movement.

Typical applications of seismic expansion joints

Seismic expansion joints are typically used where larger structural movements are expected. These situations differ from normal slab articulation and usually involve independent movement between structural elements.

Examples may include:

- crossing a structural seismic separation joint within a building
- crossing between base-isolated structural components
- connecting services between separate building blocks designed to move independently.

In base-isolated buildings, services crossing the isolation interface should accommodate the predicted range of movement specified by the structural engineer. In these situations, seismic expansion joints are commonly selected to provide sufficient axial and angular flexibility.

The selection and configuration of seismic expansion joints should be coordinated with the structural engineer and based on the predicted differential movement for the project.

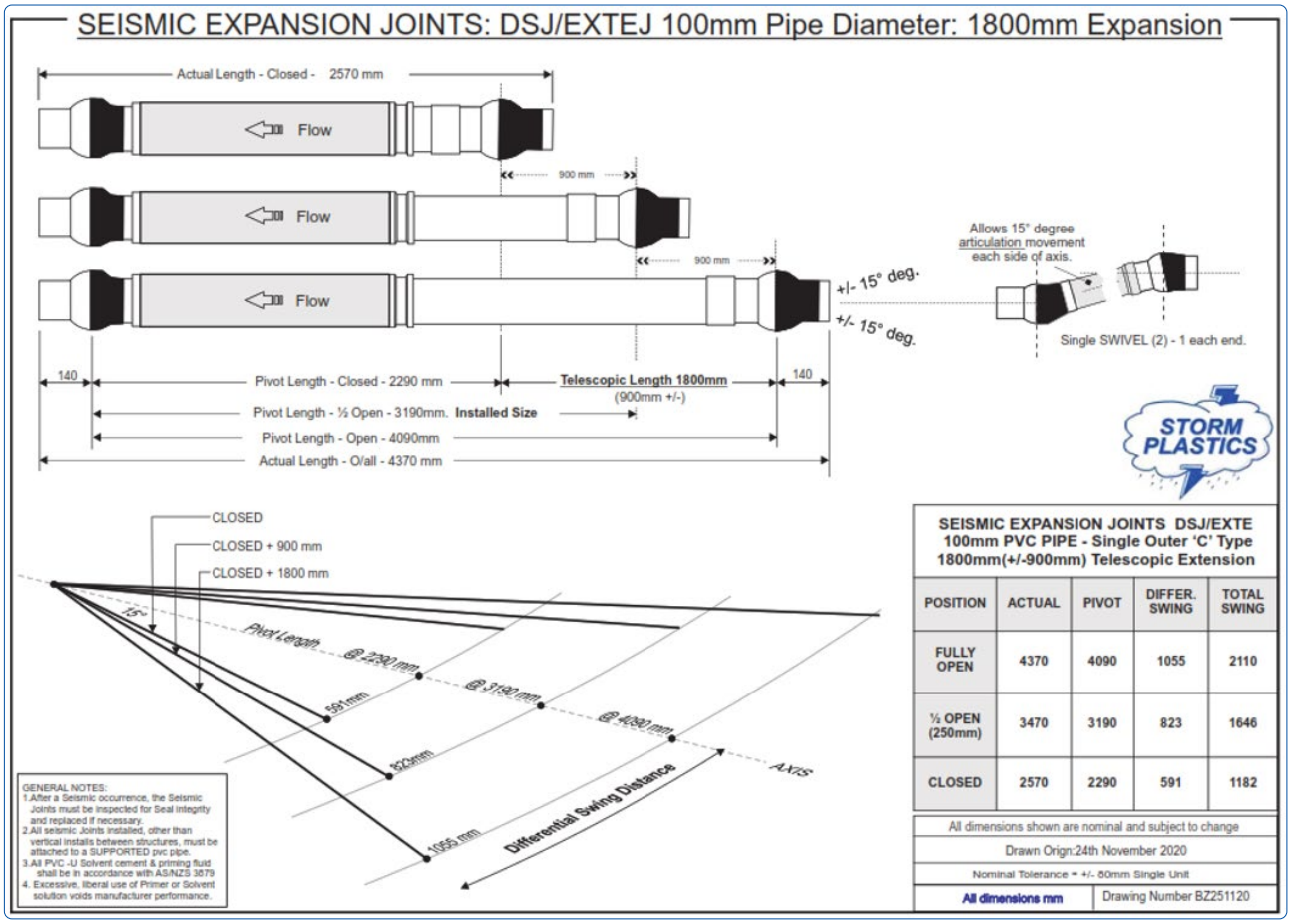


Figure 7. Example of stormplastics seismic expansion joints DSJ/EXTE 100mm uPVC pipe with ± 900mm telescopic extension

Installation tips:

- Confirm expansion joints remain approximately **mid-travel** at handover
- Avoid fixed supports directly adjacent to articulation joints
- When crossing structural seismic joints, confirm joint capacity exceeds predicted differential movement.

Seismic bracing and supports in a suspended situation

Above-slab pipework requires both flexibility and restraint. The objective is to allow movement while preventing uncontrolled displacement.

Seismic restraint general requirements (NZS 4219)

- Sliding supports should allow expansion without restraint.
- Pipes < 50mm Ø suspended by hangers ≤ 150mm long generally require no special restraint unless specified in NZS 4219.
- Maintain clearances in accordance with Table 15 of NZS 4219.
  NOTE: this standard is one of the 120 construction standards MBIE sponsors, so it can be accessed free on the Standards New Zealand website.

Condition being considered	Minimum clearance (mm)	
	Horizontal	Vertical
Unrestrained component to unrestrained component	250	50
Unrestrained component to restrained component	150	50
Restrained component to restrained component	50	50
Penetration through structure (such as walls and floor)	50	50
NOTE: Ceiling hangers and braces are considered to be restrained components for the purposes of this table.		

Figure 8. ***Minimum clearances between building services and adjacent components. Table 15 of NZS 4219.***

- Provide lateral bracing where required by a seismic restraint designer.

Thermal and structural expansion general requirements (AS/NZS 2032 – Installation of PVC pipe systems)

- Support spacing should follow Table 6.3 based on pipe size, fluid density, and temperature.

	Maximum spacing of supports (cold pipelines), m	
Nominal size of pipe	**Graded pipelines**	**Vertical pipelines**
32	0.9	1.8
40, 50	1.0	2.0
65 to 150	1.2	2.5
>150	1.5	3.0

Figure 9. ***Maximum allowable support spacing for uPVC based on the pipe size and operating temperature. Table 6.3 of AS/NZS 2032.***

- Fixed supports should be provided at every expansion fitting to prevent unwanted pipe movement.
- Expansion joints should allow ±10mm axial movement minimum.
- Rubber-ring jointed systems may be used for expansion where recommended by the manufacturer.

Case studies and lessons learned



Figure 10. ***Coastal site (NZ):*** *400mm ground settlement over 10 years; articulated expansion joints installed to maintain compliance and watertightness.*



Figure 11. **Wellington underground carparks:** *this application accommodates both building movements.*



Figure 12. **Base isolation construction:** ± *650mm lateral displacement tolerated with seismic expansion joints.*

Lesson:

Articulated joints and oversize penetrations reduce stress concentration and allow drains to “move with the building.”

Post-earthquake maintenance and repair

Following seismic or subsidence events:

- CCTV to inspect internal integrity and grades of all pipework
- hydrostatic testing where practical
- inspect all visible joints for misalignment, leakage, or visible stress marks
- confirm mechanical joints remain approximately mid-travel (retaining capacity for extension and compression)
- replace damaged rigid fittings with flexible couplings where appropriate and in accordance with the project requirements
- document repairs and update as-built drawings.

Ethics and integrity



Designing and installing drainage systems carries a responsibility to protect public health, preserve hygienic conditions within buildings, and prevent environmental contamination. In New Zealand, this means recognising that drainage systems may be exposed to earthquakes, ground movement, and thermal expansion over their service life, and allowing for these movements where they are reasonably expected. Ethical practice involves understanding the real conditions a system will experience, following the intent of the relevant standards, collaborating with other professionals, and installing drainage systems in a way that allows controlled movement without compromising performance. By focusing on resilience and long-term performance, practitioners help ensure drainage systems remain safe, functional, hygienic, and easier to inspect and repair following a seismic event.

03

Topic 03:
Understanding backflow risks with modern hygiene fixtures

Bidet toilet seats and handheld spray hoses are becoming increasingly common in New Zealand homes, offering improved hygiene and water efficiency. However, without proper backflow protection they can pose serious risks to our drinking water supply. This topic explores the health risks, compliance requirements, and practical steps plumbers must take to ensure every installation meets New Zealand's high standards for safety and performance.

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Introduction

Bidets, douche seats, handheld bidet hoses and WC trigger sprays are becoming increasingly popular in New Zealand homes, particularly with the growing influence of overseas markets. By removing the need for toilet paper, they are considered by some a more environmentally friendly, cleaner way to practise hygiene.

However, when there is inadequate backflow protection these devices also present a risk to water supplies. This is why bidets, douche seats, handheld bidet hoses and WC trigger sprays have all been added to the list of high-hazard examples in G12/AS1.

At present, some may claim to be compliant with backflow prevention requirements. But not all are.

In this topic we'll cover:

- backflow and associated health risks
- regulatory requirements and standards for installations
- how to correctly identify and install backflow prevention devices for bidet seats and other fixtures
- what to look out for with products which claim to have integrated backflow which meets NZ standards around backflow prevention
- common installation errors
- plumbers' responsibilities around hygiene fixtures.

Backflow and associated health risks

All plumbers were taught in their apprenticeship that there are two types of backflow events:

1. **Back siphonage** – Negative pressure in the supply line (e.g. when a hydrant is opened).
2. **Back pressure** – Downstream pressure exceeds supply pressure (e.g. from pumps or heating systems).

The predominant risk with bidets, douche seats, handheld bidet hoses and WC trigger sprays is back siphonage (Note: there may be exceptions to this). Back siphonage can happen when there is a cross-connection from either the spray gun may be submerged in the toilet bowl, or the spray wand from the bidet toilet seat may be below the flood level of the toilet bowl.

Ultimately, the risk with backflow is that contaminants from the toilet can re-enter our drinking water supply.

The contaminants can include:

- **Pathogenic bacteria** – E. coli, salmonella, shigella
- **Viruses** – Hepatitis, norovirus, rotavirus



Figure 1. ***Spray gun cross connection hazard***

- **Parasites** – Giardia, cryptosporidium
- **Chemical residues** – From cleaning products, disinfectants, or deodorising blocks.

If this water is drawn back into the drinking water supply, even in trace amounts, it can pose a serious and immediate public health risk.

Health risks from a toilet can include:

- **Acute gastroenteritis** – vomiting, diarrhoea, dehydration
- **Hepatitis A infection** – liver inflammation
- **Parasitic infection** – Giardia, cryptosporidium.

The degree of health risk can vary depending on multiple factors such as:

- **Contaminant type** – type of human waste or chemicals
- **Strength of the contaminant** – how diluted is it in the water
- **Extraneous factors** – in the case of human waste, are there any other viruses contaminating it.

Regulatory requirements

Under section 123 of the Building Act 2004, a building is considered 'insanitary' if it does not have a supply of potable water adequate for its intended use. So, if a backflow event occurs and the water is contaminated, the dwelling is then considered 'insanitary.'

The New Zealand Building Code Clause G12.3.2 requires:

> "A potable water supply system shall be–
>
> (a) protected from contamination; and
>
> (b) installed in a manner which avoids the likelihood of contamination within the system and the water main;"

We need to protect the potable water and avoid the 'likelihood' of a backflow event. We might assume that because a backflow event is unlikely in a toilet, only a low level of protection is required. But that's not the whole story. We also need to consider the seriousness of the event.



Figure 2. ***AI bidet toilet seat***

While a backflow event from a toilet may be unlikely, the consequences can be huge. And as more and more of these hygiene fixtures are installed, the chances of a backflow event occurring with one of them increases. This is exacerbated in some of our cities with failing water infrastructure. Each new leak that is repaired presents an opportunity for back siphonage when the water flows back.

This is why bidets and douche seats, handheld bidet hoses, and WC trigger sprays are cited among the high hazard examples in the acceptable solutions G12/AS1 clause 3.3.1.

How to correctly identify and install backflow prevention devices for bidet seats and other fixtures

When it comes to bidets and douche seats, handheld bidet hoses, and WC trigger sprays, the type of backflow event will be back siphonage.

These devices are also listed in the acceptable solutions examples of high-risk backflow.

According to the acceptable solutions G12/AS1 Table 2, there are four acceptable types of backflow protection for high-risk back siphonage.

- Air gap.
- Reduced pressure zone device.
- Pressure-type vacuum breaker.
- Atmospheric vacuum breaker.

Table 2: Selection of Backflow Protection
Paragraphs 3.4.5 and 3.7.2

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 type vacuum breaker		√		√		√
Hose connection vacuum breaker (see **Note 4**)						√

Notes:

1. *Air gaps* must not be instaled 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 suffcient to ensure full closing of the valve.
4. Hose connection vacuum breakers are designed to be under pressure only when water is being drawn from the water supply system and for short, intermittent periods of time.

Figure 3. G12/AS1 Table 2 Acceptable solutions for selection of backflow protection

As always, the building code also allows for Alternative Solutions. But they must meet all the mandatory requirements of the building code and in the case of consented work must be approved by the Building Consent Authority.

When considering relevant backflow prevention methods, some things to consider regarding the installation include:

- if the device spills when activated, is it in a location where it's unlikely to damage property
- in the case of an RPZD, is there a provision for drainage if located indoors
- in the case of an air gap, is it sufficiently sized
- is there space for unions and isolation valves on either side to allow for maintenance
- is there adequate water pressure for it to function correctly
- is it an adequate height.

Figure 1: Air Gap Separation
Paragraph 3.6.1

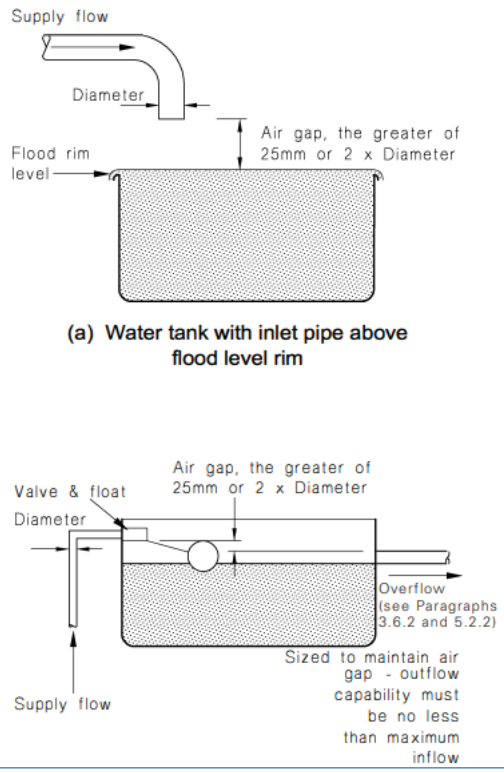


Figure 4. ***Air gap requirements***

Of course, you could always avoid the need for backflow protection by supplying it with grey water.

Remember: only the potable water supply requires protection. Many buildings have a separate grey water (or rainwater) system supplying fixtures which don't need potable water, such as toilets. In these cases, backflow protection may not be required. However, you do need to ensure there are no cross-connections, or that any that exist have the appropriate level of backflow protection.

Evaluating products which claim to have integrated backflow, meeting NZ standards for backflow prevention

With the increasing range of products entering the New Zealand market, it's essential to ensure that what is installed is compliant.

AS/NZS 2845.1:2022 is the standard for the materials, design and performance requirements of backflow prevention devices. Bidet toilet seats may have an incorporated backflow protection method in them which complies with this standard. But that doesn't mean the device also complies with the installation requirements.

As installers, we also need to check that the backflow protection method complies with the installation requirements. This means ensuring it is suitable for the hazard level.

If a product claims to be compliant, we should ask ourselves these questions:

- is it the method of protection suitable for the hazard level
- can I ensure it remains safe/Is the backflow prevention method testable to ensure it functions?
- what information does the manufacturer/supplier provide to show how it meets NZBC requirements.

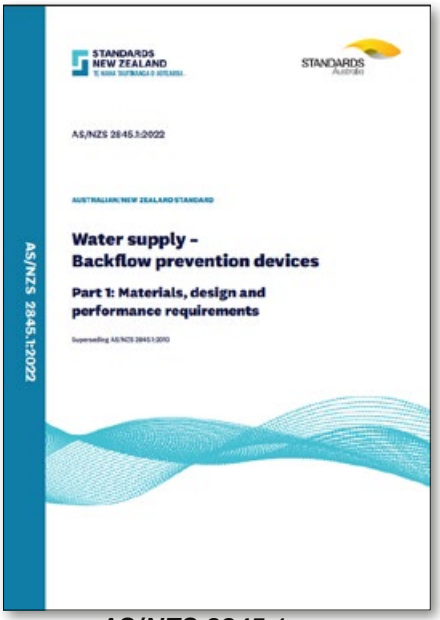


Figure 5. ***AS/NZS 2845.1 cover page***

Common installation errors

Not installing backflow protection

By far the most common error is that bidets and douche seats, handheld bidet hoses, and WC trigger sprays are installed without backflow protection.

Many of the products, especially those bought from overseas marketplaces, advertise they can be installed by the homeowner.

Let's be clear. In New Zealand, installing these devices is restricted work and can only be done by licensed plumbers.



Figure 6. ***Spray gun cross connection hazard***

Over specifying the protection

There's nothing wrong with going over and above the protection requirements. But sometimes this can be an unnecessary extra cost to the consumer.

Relying solely on the incorporated device

While things like incorporated check valves do help provide a layer of protection, they will not meet the installation requirements for a high-hazard back-siphon situation. Additionally, they are often not testable, so there's no way of confirming their ongoing performance. If you do rely on the incorporated backflow protection, do your due diligence to ensure it is suitable for the hazard.

Understand plumbers' responsibilities around bidet toilet seats and spray guns

Plumbers are often the last line of defence when protecting our water supplies. It can be challenging when consumers are unwilling to pay for what needs to be done, especially when it can mean missing out on the work. But it is essential that work is completed compliantly so that our water supplies are protected.

New installations

If you are asked to install new bidets and douche seats, handheld bidet hoses, or WC trigger sprays, you must ensure your work meets all the mandatory requirements of the building code.

Existing installations

You may find yourself attending an existing installation where there is a clear cross-connection hazard from bidet toilet seat or spray guns. In this circumstance, best practice is always to recommend to the client that it be made compliant. However, the Building Act 2004 essentially says that upon completion of your work, the installation can't be any less compliant than before you started that work. All work you do must comply, but you are not responsible for making sure the existing work complies.

42A Building work for which building consent is not required under Schedule 1

(1) Despite section 40, subject to the conditions set out in subsection (2) and whether or not a building consent would otherwise have been required, a building consent is not required for building work in the following categories:

- (a) building work described in Part 1 of Schedule 1; or
- (b) building work described in Part 2 of Schedule 1 that is carried out by an authorised person (*see* subsection (3)); or
- (c) building work described in Part 3 of Schedule 1 if the design of the building work has been carried out or reviewed by a chartered professional engineer and the building work has been carried out in accordance with that design.

(2) Subsection (1) is subject to the following conditions:

- (a) the building work complies with the building code to the extent required by this Act:
- (b) after the building work is completed, the building,—
  - (i) if it complied with the building code immediately before the building work began, continues to comply with the building code; or
  - (ii) if it did not comply with the building code immediately before the building work began, continues to comply at least to the same extent as it did then comply:
- (c) the building work does not breach any other enactment:
- (d) the building to which the building work relates is not a hazardous substance location that is required to be authorised under the Health and Safety at Work Act 2015 or any regulations made under that Act.

(3) In subsection (1)(b), **authorised person** means a person who is authorised under the Plumbers, Gasfitters, and Drainlayers Act 2006 to do the work, except for a person who is authorised under section 15, 16, 19, or 25 of that Act.

Section 42A: inserted, on 28 November 2013, by section 18 of the Building Amendment Act 2013 (2013 No 100).

Section 42A(2)(d): replaced, on 1 December 2017, by section 55 of the Hazardous Substances and New Organisms Amendment Act 2015 (2015 No 72).

Figure 7. *Building Act 2004 excerpt*

Conclusion

As bidets and douche seats, handheld bidet hoses, and WC trigger sprays become more common in New Zealand homes, it's vital that plumbers stay on top of our compliance responsibilities. Understanding the backflow risks and selecting the right protection method are all part of ensuring the safety of our drinking water. Every installation, whether new or existing, presents an opportunity to uphold the standards that protect our communities and maintain trust in the plumbing trade.

Backflow prevention isn't just about ticking a compliance box, it's about safeguarding public health. Each time we choose to install correctly, test thoroughly, and educate clients on maintenance, we're helping protect one of New Zealand's most valuable resources: clean, safe drinking water. It only takes one mistake to contaminate a supply, but our professional diligence can help prevent it.

Ethics and integrity

Modern hygiene fixtures may improve comfort and cleanliness, but they also introduce real risks if they are not installed correctly. Ethical plumbing practice means looking beyond what is convenient, low cost, or claimed to be compliant, and focusing instead on what genuinely protects public health. Backflow prevention is not optional or negotiable, it is a core responsibility that comes with working on potable water systems.

Plumbers play a critical role as the last line of defence for New Zealand's drinking water. Acting ethically means understanding the risks, applying the correct level of protection for high hazard fixtures, refusing unsafe shortcuts, and clearly explaining requirements to clients.

04

Topic 04:
Hot water ring mains

Hot water ring mains are a common means of distributing hot water through larger buildings and/or specifically designed hot water installations.

Designing and installing hot water recirculation systems can be one of the most challenging parts of the job for many plumbers.

There are many factors to consider with these systems to ensure they operate and function safely and efficiently.

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Introduction

Hot water ringmains distribute water via circulatory systems that are designed to distribute heated water (hot water) typically at 60°C or higher.

Note: Warm water systems circulate at lower temperatures, this chapter focuses on hot water systems only.

Circulatory ring main systems are commonly used in the design and installation of hot water systems to reduce the time taken for the heated water to reach the outlet. This is achieved by circulating heated water through the system and returning the slightly cooler hot water to the heating plant using a pump or pump set, usually installed on a return line located at the hot water plant.

Some overseas studies have shown that the average home wastes more than 13,000 litres of heated water per year waiting for hot water at the desired temperature to arrive at fixtures.

Beyond the costs of wasted water and energy, it's important to understand that some domestic hot water delivery systems can create conditions that allow pathogens, such as legionella bacteria, to thrive.

These conditions create growth environments favourable to the bacteria. If water containing these pathogens is discharged through fixtures such as showers, the mist created by the shower can be inhaled. This can lead to a serious and even potentially fatal disease. Thus, all domestic hot water delivery systems should be designed to minimise the potential presence of such pathogens.

One of the best ways to minimise wasted water and energy in domestic hot water delivery systems is by circulating hot water through the system at times when it would otherwise not be moving because of no demand at the fixtures.

Such systems are called "recirculating" domestic hot water systems. They are the principal focus of this CPD topic.

However, there is more to a recirculating ring main system than just a return pump.

Let's now take a closer look at some of the key points in a ring main system.

Codes and Standards

What do we use to design and size hot water ring main systems?

A multitude of international code standards and good practice guidelines are used within hydraulic engineering practices to size complex ring main systems for projects such as large public hospitals.

For domestic and lighter commercial ring main systems in New Zealand the Building Code Clause G12 Water Supplies is utilised. This enables the practitioner to call on the Verification Methods and Acceptable Solutions associated with that clause.

However, understanding what is an acceptable solution for a ring main system is an important starting point. As noted below, ring main circulating systems are outside the scope of G12/AS1.

What does that mean in practical terms?

It means that the hot and cold water services system will need to be designed and installed to G12/AS3 (AS/NZS 3500.1 and 4).

This is important to remember as the plumbing industry moves into self-certification. Knowing, understanding and applying the correct acceptable solutions will be imperative to a 100% compliant self-certified hot and cold water system.

Figure 1 below provides a snapshot of the Verification and Acceptable Solutions in NZBC G12.

New Zealand Building Code G12 Verification Method and Acceptable Solutions	
Section	**Comments**
VM1 water supply pipework sizing	This is the Plumbing Engineering Services Design Guide and can be used as a means of establishing the maximum simultaneous flow rates for hot and cold water systems
AS1 water supplies (above and below ground)	Hot water flow and return circulating systems are outside the scope of this acceptable solution. An acceptable solution for the design and installation of hot water circulating systems can be found in AS/NZS 3500.4, which is referenced in G12.
AS2 solar water heaters	This applies to hot water solar systems
AS3 (AS/NZS 3500 parts 1&4)	This is the acceptable solution used when designing and installing hot water ring mains in New Zealand. Note: Alternative solutions utilising overseas standards can also be used, typically applied in large complex ring main systems such as hospitals.

Figure 1. ***A snapshot of the Verification and Acceptable Solutions in NZBC G12.***



Figure 2. ***Codes and Standards. Source: MBIE***

Layout

The main hot water loop piping is sized on loading units and index length, similar to sizing a cold water system. The return piping is sized on the circulation flow only.

Keep the runs simple and try to ensure that the branches off the main run are kept as short as possible to minimise energy and water losses, while also ensuring that a maximum of **no more than 2 litres volume** of water is sitting in that dead leg.

Figure 3 below provides a couple of examples of good and bad layouts.

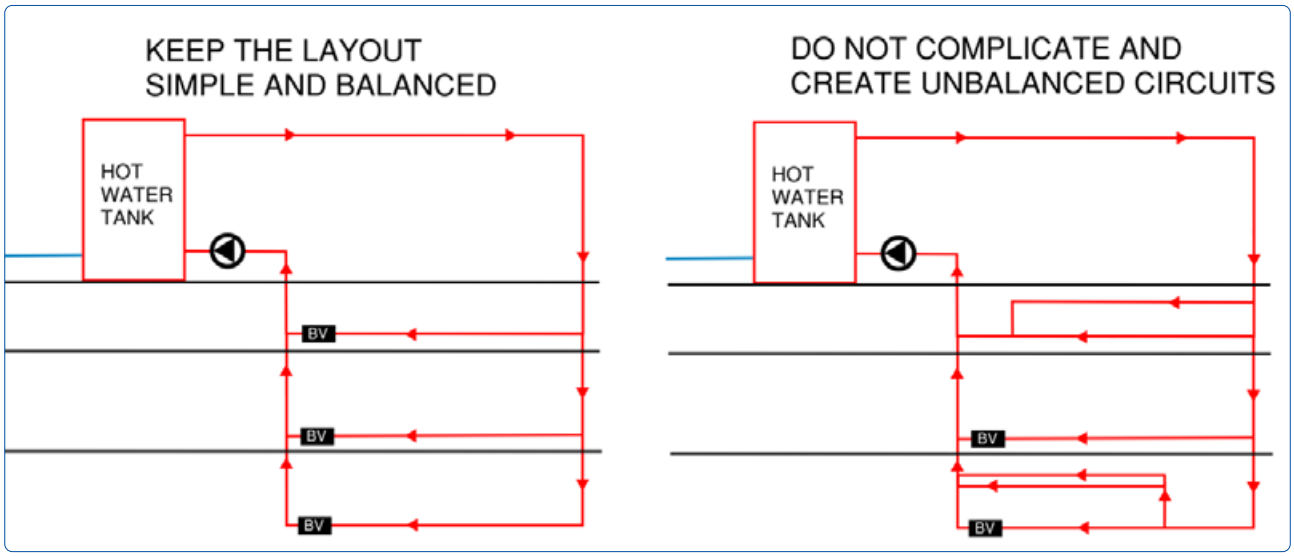


Figure 3. ***Good and bad layout examples. Source: PHC***

Water temperature and control

Maintaining the correct hot water temperatures within the hot water ring main is critical to preventing the onset of opportunistic pathogens such as legionella.

AS/NZS 3500.4 section 10 states:

- The delivery temperature flowing from a hot water heater, bank of water heaters or heated water storage vessel shall not be less than 60°C.
- The return water temperature to hot water heater, bank of water heaters or heated water storage vessel shall not be less than 55°C.

That is a delta T of 5°C.

It also must be noted that section 10 is limited to hot water ring main systems up to only 65°C.

Some of the challenges maintaining the correct circulating temperature are (but not limited to):

- maintaining the hot water circulation temperature during periods of high demand, so storage sizing is important
- preventing overheating of the hot water ring main system, which can be detrimental to the pipe work system
- maintaining the ring main temperature but ensuring the correct temperatures to sanitary fixtures, i.e. careful placement of temperature control devices
- minimising dead legs off the ring main.

There needs to be a careful balance to maintaining the correct circulating temperatures to minimise the onset of opportunistic pathogens such as legionella (refer figure 1.1 for a snapshot of how different temperatures affect legionella) but ensuring the temperature being delivered to the sanitary fixtures is still compliant with G12/AS3. (clause 1.11.1 refers back to G12/AS1.)

The delivered hot water temperature at the outlet of any sanitary fixture used for personal hygiene shall not exceed:

- 45°C for early childhood education and care centres, schools, old people's homes, institutions for people with psychiatric or physical disabilities, hospitals
- 50°C for all other buildings.

It is important that the correct temperature control devices are selected for the above temperatures, remembering that Table 8A within G12/AS1 does not mention tempering valves where a maximum delivery temperature of 45°C is required.

Refer Figure 4 over the page.

Table 8A: **Acceptable temperature control devices where a maximum delivery temperature of 45°C is required by Paragraph 6.14.1**
Paragraph 6.14.2 and Figure 16

Device type	Standard
Thermostatic mixing valve (TMV)[1234]	AS 4032.1 BS EN 1287 (Low pressure) BS EN 1111 (High pressure)
Thermostatically controlled tap[124]	AS 4032.4

Notes:

1. Temperature control device materials and components shall comply with Paragraph 2.0.
2. Each thermostatic mixing valve or tempering valve shall have a *non-return valve* fitted to the hot and cold water supply. These devices may be fitted separately or form an integral part of the thermostatic mixing valve.
3. See Figure 16 for acceptable methods of limiting hot water delivery temperature using a thermostatic mixing valve.
4. Delivery temperature control devices require routine maintenance and performance testing. For information on maintenance, refer to AS 4032.3.

Table 8B: **Acceptable temperature control devices where a maximum delivery temperature of 50°C is required by Paragraph 6.14.1**
Paragraph 6.14.2 and Figure 16

Device type	Standard
Thermostatic mixing valve (TMV)[1234]	AS 4032.1 BS EN 1287 (Low pressure) BS EN 1111 (High pressure)
Thermostatically controlled tap[14]	AS 4032.4
Tempering valve (TV)[1234]	AS 4032.2 NZS 4617
Instantaneous (continuous flow) temperature limited water heater[5]	AS 3498[6]

Notes:

1. Temperature control device materials and components shall comply with Paragraph 2.0.
2. Each thermostatic mixing valve or tempering valve shall have a non-return valve fitted to the hot and cold water supply. These devices may be fitted separately or form an integral part of the thermostatic mixing or tempering valve.
3. See Figure 16 for acceptable methods of limiting hot water delivery temperature using a thermostatic mixing valve or tempering valve.
4. Delivery temperature control devices require routine maintenance and performance testing. For information on maintenance, refer to AS 4032.3.
5. An instantaneous (continuous flow) temperature limited water heater is a water heater that limits the temperature of hot water delivered at the outlet of any sanitary fixture used for personal hygiene supplied by the water heater. Where an instantaneous (continuous flow) water heater is adjusted to deliver hot water exceeding 50°C, additional temperature control device(s) shall be provided to ensure delivered hot water temperature at the outlet of any sanitary fixture used for personal hygiene does not exceed 50°C.
6. Modification to AS 3498 – delete sub-clause 7.3.2.1(a) and sub-clause 7.3.2.2(c). This modification means that this acceptable solution does not include the maximum installer temperature adjustment requirement for temperature limited water heaters.

Figure 4. *Tables 8A and 8B. Source: MBIE NZBC G12*

Legionella

The threat of legionella has been discussed in previous CPD years, but a few important issues are mentioned below.

Legionella, the bacterium that causes legionnaires' disease, can also spread through the potable water system. The bacterium is known to survive in chlorinated water.

Building water systems include many micro-environments conducive to microbial growth, including dead ends and other low-use regions, as well as hot water tanks and hot water pipes where temperatures might accelerate legionella regrowth.

Interesting fact: The first case of legionnaires' disease in New Zealand was reported in 1979. Legionellosis became a notifiable disease in June 1980.

Figure 5 provides a visual of the differing temperature ranges and the survivability of legionella.

Temperature	Effect on *Legionella*	Cell cultivability
Above 70°C	Disinfection temperatures	Instant death
66°C	Disinfection temperature	Legionella will die in 2 minutes
60°C	No active growth	Legionella will die in 32 minutes
55°C	No active growth	Legionella will die in 5–6 hours
50–55°C	No active growth	Slow decline in viable cells
47–50°C	No active growth	Legionella can survive but do not multiply
45–47°C	Slow growth	Legionella multiply slowly
35–45°C	Optimum growth range	Rapid increase in viable cell counts
20–35°C	Active growth range	Viable cell count determined by nutrient level
Below 20°C	No active growth	Legionella can survive but is dormant

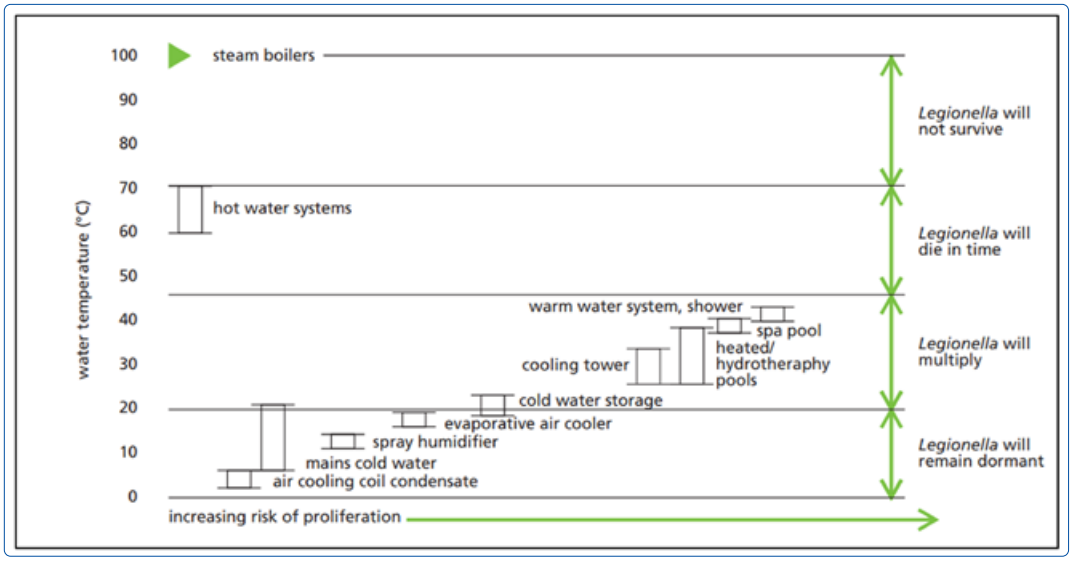


Figure 5. ***Legionella temperature ranges source: Te Whatu Ora***

Master tempering control

To ensure that the ring main is not exposed to excessively hot water temperatures a master tempering valve is commonly utilised on the outgoing flow line. This is particularly important if plastic piping systems are being used in the hot water network or if the selected pipe material has strict operating parameters.

This master tempering valve can be set to ensure that the outgoing flow temperature into the ring main does not exceed say 65°C.

This ensures longevity of the system and components.

Figure 6 demonstrates a simple set up using the Legiomix from Waterware.

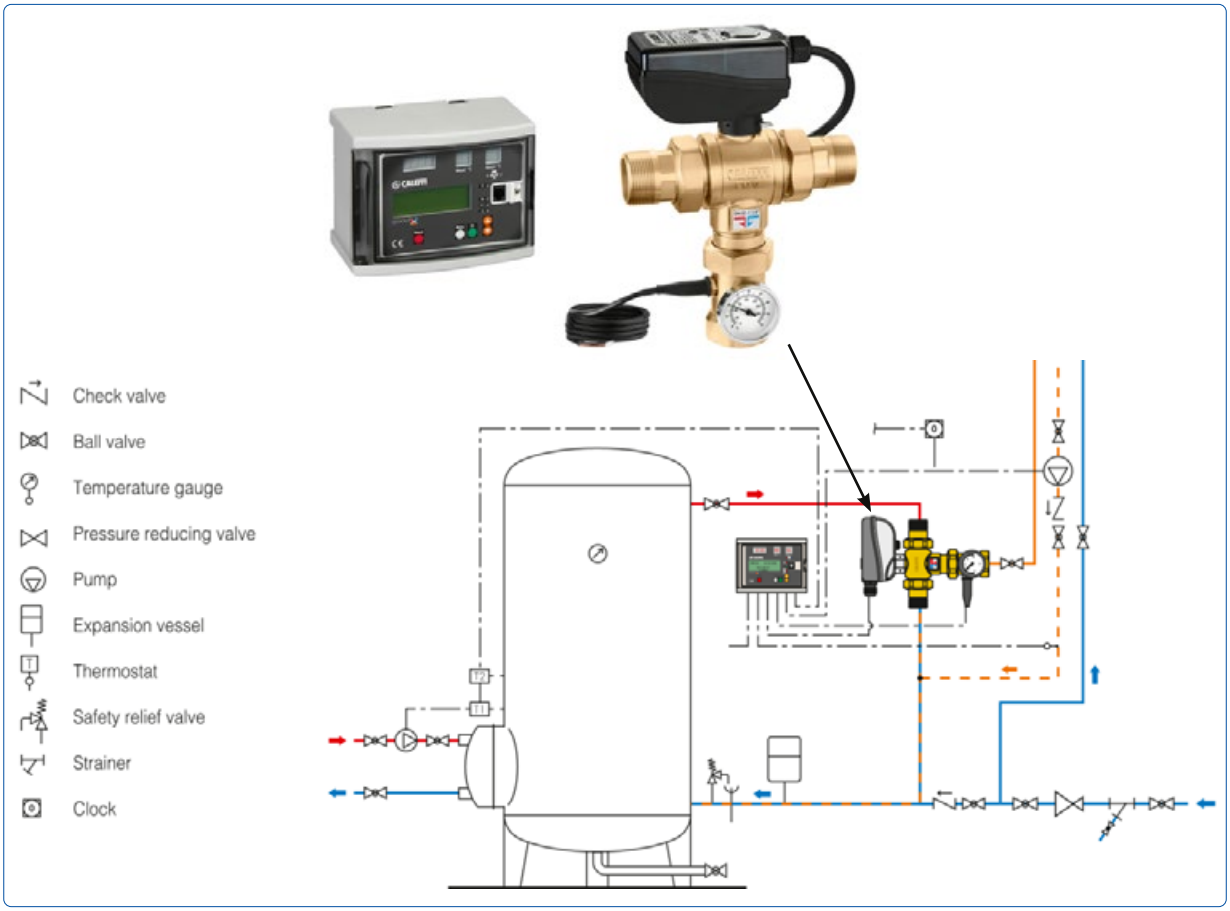


Figure 6. ***Master tempering valve example. Source: Waterware***

Branch offtakes and water volumes

Branches off the circulating ring main should be kept as short as possible, with a maximum water volume of 2 litres.

Circulation systems can include infrequently used fixtures which create what is known as a “dead leg.” This water ultimately stagnates, becoming a potential risk for pathogen growth.

Legionella and similar waterborne bacteria prefer stagnant water to flowing water, as stagnant water makes it easier for the bacteria to establish, multiply and spread throughout other parts of the system.

What is a blind end/dead end?

A blind or dead end is a length of water pipework closed at one end through which no water passes. A good example of this would be where a wash hand basin has been removed and the hot and cold supply pipework has simply been capped off to leave pipes filled with stagnating water; these should be completely avoided.

Dead legs

As mentioned earlier, the maximum allowable hot water dead leg length is 2.0 litres of water.

NOTE NZS 4305 Energy Efficiency – Domestic Type Hot Water Systems provides a table based on nominal bore pipe specific to a domestic run to a kitchen only. **All** plumbing practitioners should already be working to these rules, which have been in force since 1996. (Figure 7)

Acceptable maximum pipe lengths	
DN10	25.0m
DN15	12.0m
DN20	7.0m

Figure 7. ***NZS 4305 – Pipe work size and acceptable length to the kitchen sink (domestic). Source: NZS 4305 Energy Efficiency 1996***

However, the recent versions of AS/NZS 3500.4 now stipulate 2 litres maximum **for all branch legs** – this is to control pathogens, as well as for energy efficiency and water saving requirements.

The tables in Figure 8 (over the page) provide some general guidance on different pipe materials and sizes with respect to water volumes within the pipework.

Type B copper

Copper (Type B)	
Internal Pipe Diameter (mm)	10.81
Nominal Diameter (mm)	15
Pipe Volume	
Length (m)	**Pipe Volume (L)**
1	0.092
2	0.184
3	0.275
4	0.367
5	0.459
6	0.551
7	0.643
8	0.734
9	0.826
10	0.918
11	1.010
12	1.101
13	1.193
14	1.285
15	1.377
16	1.469
17	1.560
18	1.652
19	1.744
20	1.836
21	1.928

Copper (Type B)	
Internal Pipe Diameter (mm)	16.9
Nominal Diameter (mm)	20
Pipe Volume	
Length (m)	**Pipe Volume (L)**
1	0.224
2	0.449
3	0.673
4	0.897
5	1.122
6	1.346
7	1.570
8	1.795
9	2.019

Copper (Type B)	
Internal Pipe Diameter (mm)	22.8
Nominal Diameter (mm)	25
Pipe Volume	
Length (m)	**Pipe Volume (L)**
1	0.408
2	0.817
3	1.225
4	1.633
5	2.042

Figure 8. ***Different pipework up to 2 litres in volume. Source: PHC***

PEX (SDR 7.4)

PEX (SDR 7.4)	
Internal Pipe Diameter (mm)	11.6
Nominal Diameter (mm)	16
Pipe Volume	
Length (m)	**Pipe Volume (L)**
1	0.106
2	0.211
3	0.317
4	0.423
5	0.528
6	0.634
7	0.740
8	0.846
9	0.951
10	1.057
11	1.163
12	1.268
13	1.374
14	1.480
15	1.585
16	1.691
17	1.797
18	1.903
19	2.008

PEX (SDR 7.4)	
Internal Pipe Diameter (mm)	14.4
Nominal Diameter (mm)	20
Pipe Volume	
Length (m)	**Pipe Volume (L)**
1	0.163
2	0.326
3	0.489
4	0.652
5	0.814
6	0.977
7	1.140
8	1.303
9	1.466
10	1.629
11	1.792
12	1.955

PEX (SDR 7.4)	
Internal Pipe Diameter (mm)	18
Nominal Diameter (mm)	25
Pipe Volume	
Length (m)	**Pipe Volume (L)**
1	0.255
2	0.509
3	0.764
4	1.018
5	1.273
6	1.527
7	1.782
8	2.036

Figure 8 continued .... ***Different pipework up to 2 litres in volume. Source: PHC***

Stainless Steel

Stainless Steel	
Internal Pipe Diameter (mm)	13
Nominal Diameter (mm)	15
Pipe Volume	
Length (m)	**Pipe Volume (L)**
1	0.133
2	0.265
3	0.398
4	0.531
5	0.664
6	0.796
7	0.929
8	1.062
9	1.195
10	1.327
11	1.460
12	1.593
13	1.726
14	1.858
15	1.991

Stainless Steel	
Internal Pipe Diameter (mm)	19.6
Nominal Diameter (mm)	22
Pipe Volume	
Length (m)	**Pipe Volume (L)**
1	0.302
2	0.604
3	0.905
4	1.207
5	1.509
6	1.811

Stainless Steel	
Internal Pipe Diameter (mm)	25.6
Nominal Diameter (mm)	28
Pipe Volume	
Length (m)	**Pipe Volume (L)**
1	0.515
2	1.030
3	1.544
4	2.059

Figure 8 continued .... ***Different pipework up to 2 litres in volume. Source: PHC***

Velocities

The plumbing and engineering standards we use for sizing hot and cold water systems apply different flows and velocities depending on whether the system is a cold water or a hot water one. Why is this?

High velocities in hot water can cause premature pipe erosion.

Diameter selection for domestic hot water return piping carries significant impacts in terms of energy, material lifespan, and biofilm development.

There is a lack of consensus on appropriate maximum velocity values, with recommendations ranging between 0.3m/s and 1.5m/s depending on the design standard. Undersized return piping can result in material failure in the form of 'pinhole leaks' caused by erosion corrosion degradation at high velocities. Oversized return piping may impose additional energy demand on the system to maintain temperature because of heat loss.

Oversized return piping also results in lowered velocities which promote sediment accumulation and a larger internal surface area for biofilm growth.

All food for thought.

The generally accepted velocities for hot and cold water systems are provided below in Figure 9.

Cold water	1.5–1.8m/s
Circulatory hot water flow (60° and greater)	0.7–0.9m/s
Hot water return (60° and greater)	0.5–0.7m/s
Non-circulatory flow hot water flow (less than 60°)	1.2–1.5m/s
Non-circulatory flow hot water flow (60° and greater)	1.1–1.2m/s

Figure 9. ***Generally accepted velocities. Source: PHC***

The picture below in Figure 10 shows a section of copper ring main where the velocities exceeded the maximum recommendation of the pipe manufacturer. You can see the internal corrosion of the elbow in the direction of flow due to the high velocities.



Figure 10. ***Example of internal pipe erosion. Source: PHC***

Pump and pipe material selection and expansion/contraction

Unlike closed loop systems with chemical additives in the water to inhibit corrosion, domestic heated water systems are continually receiving fresh water with significant dissolved oxygen content. This can lead to the corrosion and degradation of pumps, and potentially of the pipe system (depending on operating parameters).

Therefore, the pump casing and impellers should be resistant to corrosion – stainless steel or bronze, or polymer for impellers of smaller pumps depending on the application.

Consideration and implementation of expansion/contraction measures are required for hot water ring main systems. Without the appropriate allowances the pipe material will eventually reach a breaking point and either split or burst.

Different pipe materials have different rates of expansion.

All materials used in plumbing services pipework experience change in dimension with change in temperature.

Thermal effects on piping materials can be quite dramatic – for this reason the design and installation of pipework material must take into consideration:

- each material type
- the method of installation
- the change in temperature either from median heat being transferred, or from the ambient temperature surrounding the pipe.

Different design provisions and methods may be applicable to different projects depending on the size, layout of the system and material selection; examples of effective solutions include deflection legs, expansion loops or expansion bellows.

Metallic pipes such as copper, for example, have a significantly lower thermal expansion rate compared to those experienced by thermoplastic pipe such as PPR.

To calculate the stress-related forces placed on plumbing piped materials, engineers use the coefficients of thermal expansion formulae.

Though we are not going to go into indepth calculations here, the table below in Figure 11 provides a visual example of the different rates of expansion per mm/m.

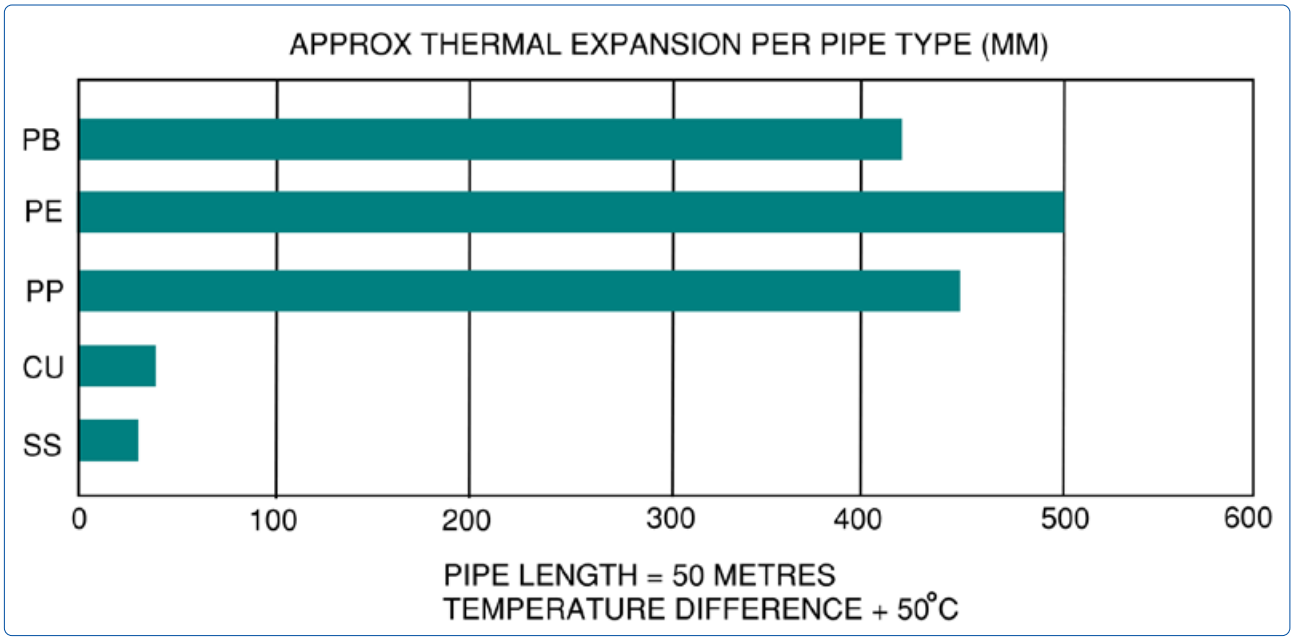


Figure 11. ***Different rates of expansion per pipe type. Source: PHC***

Insulation

Even though the pipework is insulated, heat can still be lost. Heat losses in a hot water recirculation system can reach up to 75% of the energy used for the supply – all wasted energy, and wasted money for your client.

The correct selection and application of the pipe insulation material is a critical yet generally overlooked component of a hot water circulatory system.

When looking at heat losses, the amount of heat lost in the circuit depends on:

- pipe material
- insulation resistance to heat conduction (“R-value”)
- insulation and pipe thickness
- pipe length
- temperature difference between the hot water and the ambient air temperature (the temperature gradient).

The heat loss is calculated in watts or kilowatts.

The object is to calculate the total heat loss from everything in the recirculation pipe network. Knowing this, we can calculate how many L/s of hot water we need to pump around the circuits to replace all the heat lost.

The most common types of pipe insulation include:

- fiberglass insulation: good for high temperatures
- foam insulation (polyethylene, elastomeric): effective for moisture resistance and preventing condensation
- mineral wool insulation: excellent fire resistance and high-temperature stability

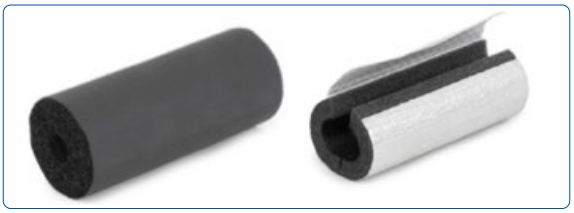


Figure 12. ***Elastometric. Source: Allproof***

- cellular glass Insulation: high durability and moisture resistance
- Calcium Silicate insulation: suitable for high-temperature industrial applications
- aerogel insulation: superior thermal insulation, lightweight, but expensive.

The most common type of pipe insulation encountered by plumbers is closed-cell elastometric and foil-faced closed-cell polyolefin foam-type insulation, as in Figure 12.

Fire resistance ratings are also an important part of the selection process for the selected insulation material.

All suppliers will have data available demonstrating compliance with AS/NZS 1530.3 (Fire rating test). Figure 13 is from a supplier's literature providing the required information around fire resistance.

Fire Rating Test: AS/NZS 1530.3 - 1999		
Regulatory Indices:		
Ignitability Index	0	Range 0-20
Spread of Flame Index	0	Range 0-10
Heat Evolved Index	0	Range 0-10
Smoke Developed Index	1	Range 0-10

Figure 13. ***Fire rating of insulation. Source: Allproof***

Low Volatile Organic Content (VOC) is also an important factor in today's modern plumbing systems. Many suppliers will provide data related to meeting much of the green building council and green star requirements.

What are VOCs?

Volatile Organic Compounds/Content (VOCs) are a group of organic chemicals that easily vaporise at room temperature, emitting gases from various solids and liquids. They contain carbon atoms and are present in numerous products, including paints, varnishes, waxes, cleaning agents, disinfectants, cosmetics, fuels, and building materials.

Exposure to elevated levels of VOCs can lead to health issues including eye, nose, and throat irritation, headaches, dizziness, and long-term effects on the respiratory and nervous systems.

In last year's CPB we looked briefly at carbon and global warming potential; this also applies to insulation. Figure 14 is a product statement.



Figure 14. ***Green product statement – Insulation. Source: Allproof***

Insulation issues with stainless steel

In recent years poor installation practices have led to premature failure of the stainless steel pipe due to vapour barrier failure, which leads to the collection of moisture beneath the insulation.

Regardless of the initial chloride levels within the insulation material, the presence of moisture can concentrate chloride in localised areas and lead to corrosion at the stainless surface. The chloride level within the insulation layer may also be enhanced from external sources (e.g. rain, wash or process water), or by evaporation. In fact, rain, wash or process waters can contain as much as 10 to 100 times the level of chloride that can leach from thermal insulation materials. Such increases in chloride level can occur during storage prior to application of the thermal insulation, as well as in service.

Chlorides and stainless steel are not a suitable combination.

Because of this, minimal chloride levels are required within the insulation. Please ensure that the insulation that you are installing is foil wrapped with all insulation and associated adhesives to have water-soluble chloride ion content not exceeding 0.05% by weight (500mg/kg).

The picture below, Figure 15, is from a New Zealand project where standard lagging was used as a means of pipe insulation over the stainless-steel ring main. This pipe started to pit and pinhole leaks presented themselves throughout the stainless ring main.



Figure 15. ***Stainless steel –premature failure with localised pitting. Source: AUSPRESS***

Insulation thickness and insulating values are also important.

Let's look at this simple example below: we have the exact same ring main system in NZS copper.

One system has 13mm insulation, the other 25mm.

The heat losses are notably less with the 25mm ring main system, consuming approx 40% less energy over a 12-month period.

Putting this into perspective, with a standard kW/hr charge of 0.35 cents, the energy cost per ring main in heat losses only is provided below:

- $1124 = 13mm
- $766 = 25mm.

The 13mm insulated ring main's heat losses are 0.34kW/hr, whilst the 25mm insulated ring main's heat losses are 0.25kW/hr – note that the volume of water passing is also lower.

Pipework material: Copper – NZS 3501		
Parameters	**Value**	**Measure**
Delivery temperature	60	°C
Storage temperature	65	°C
Ambient temperature	15	°C
Insulation thickness 13 mm	13	mm
Insulation thermal conductivity	0.04	WmK
Desired return temperature	58	°C
Required velocity	0.8	m/s
Ringmain max heat loss	2	°C
Temperature differential	45	°C

15 mm	5.00m	9.76 W/m	48.79 W
20 mm	25.00m	11.65 W/m	291.75 W

Total heat loss	.34 kW
Flow rate	0.04 L/s
Volume	0.15 m3/h
Return pipe size	15 mm
Pump flow rate	0.10 L/s

Figure 16. ***13mm insulation. Source: PHC***

Pipework material: Copper – NZS 3501		
Parameters	**Value**	**Measure**
Delivery temperature	60	°C
Storage temperature	65	°C
Ambient temperature	15	°C
Insulation thickness 13 mm	25	mm
Insulation thermal conductivity	0.04	WmK
Desired return temperature	58	°C
Required velocity	0.8	m/s
Ringmain max heatioss	2	°C
Temperature differential	45	°C

15 mm	5.00m	7.21 W/m	36.03 W
20 mm	25.00m	8.38 W/m	209.51 W

Total heat loss	.25 kW
Flow rate	0.03 L/s
Volume	0.11 m3/h
Return pipe size	15 mm
Pump flow rate	0.10 L/s

Figure 17. ***25mm insulation. Source: PHC***

Best practices for lagging pipe

To maximise the benefits of lagging pipe, follow these best practices:

- **Select the right material:** choose insulation material based on your specific requirements, considering factors such as temperature range, noise reduction, environmental conditions and material compatibility
- **Ensure proper installation:** proper installation is crucial for optimal performance. Hire a professional if you are unsure about the process (Figure 18 below provides 2 x examples good and bad)
- **Maintain regularly:** inspect pipe lagging regularly for signs of wear, damage, or moisture infiltration, and replace it when necessary
- **Comply with regulations:** ensure your pipe lagging installation adheres to local building regulations and industry standards for fire safety and efficiency
- **Consider pipe accessibility:** when installing lagging pipe, ensure that essential components, such as valves and fittings, remain accessible for maintenance and repairs.

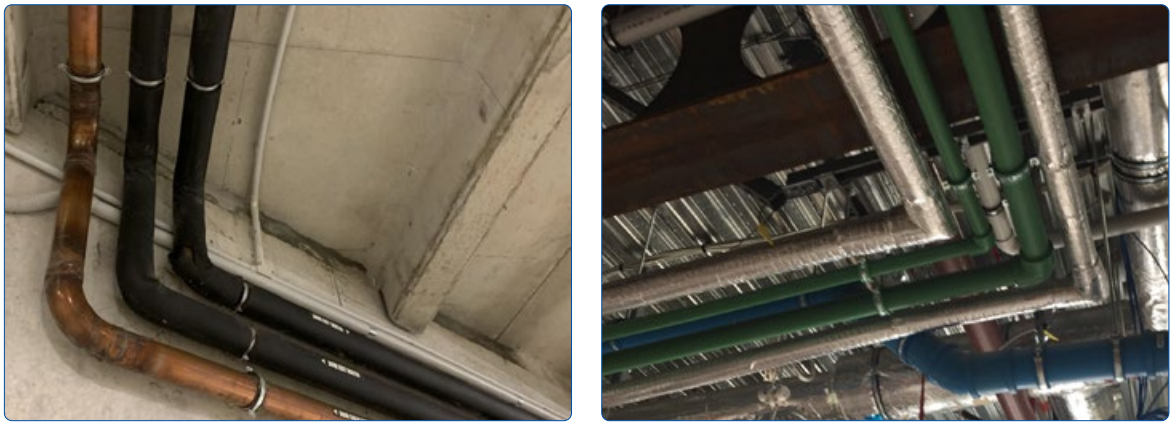


Figure 18. ***Examples of exposed and unexposed brackets. Source: PHC***

Pump selection

Hot water circulator pump flow is established on the total heat loss calculated for the linear length of insulated pipework installed in a flow and return system, there are many styles of recirculating pumps, sizes duties etc, Figure 19 provides some examples.

Factors that need to be considered in the design, selection and installation of hot water circulating pumps are:

- determination of flow requirement
- lineal length of pipework at differing sizes in flow and return pipework system
- type of hot water insulation and heat emission in w/m
- delta T – desired temperature difference between flow temperature at outlet of hot water plant and return temperature at hot water plant
- total head
- head loss in system, including pipe and fittings for calculated flow
- velocity to be kept to a minimum
- piping material.

Hot water circulator pumps

The recirculation pump duty

There are two parts to the hot water recirculation pump duty:

- **Flow rate**

  The pump must be capable of overcoming the heat loss from all of the system's pipework. The heat loss through the system is calculated in kW, which can be converted to a flow rate.

- **Pressure**

  The pump must be capable of overcoming the pressure lost through the system's pipes, valves, and fittings at the heat loss flow rate in the 'index circuit' only.

The 'index circuit' is the circuit, always measured to and from the hot water plant, that has the most pressure loss when compared to other circuits. You do not need to combine the pressure loss through every circuit.

The pressure loss/gain from changes in height should not be included in the calculation. Because it is a closed-loop system, any changes in height are always equalled downstream in the system. What goes up must come down.

To calculate the recirculation pump flow rate you need to know the following information:

- length of each pipe diameter
- the system's 'delta T' (the difference between the flow and return system temperatures)
- ambient air temperature (usually 21°C in buildings)
- insulation diameter and thickness
- air speed (usually 1m/s in buildings).

With this information, you can undertake accurate calculations by following some complex physics equations.

Alternatively, insulation manufacturers usually have simpler heat loss data which you can use for your flow rate calculations.

Recirculation pump pressure is calculated through the pressure losses through the system's pipe, valves and fittings.

Once you have calculated the recirculation pump duty and head you need to select the best recirculation pump.

To check whether a pump is suitable for your design, you need to check its pump curve.

The pump curve in Figure 20 indicates what flow and pressure the recirculation pump is capable of supplying (for this example we have selected 3.0m of head).



Figure 19. ***Examples of different circulation pumps Source: PHC***

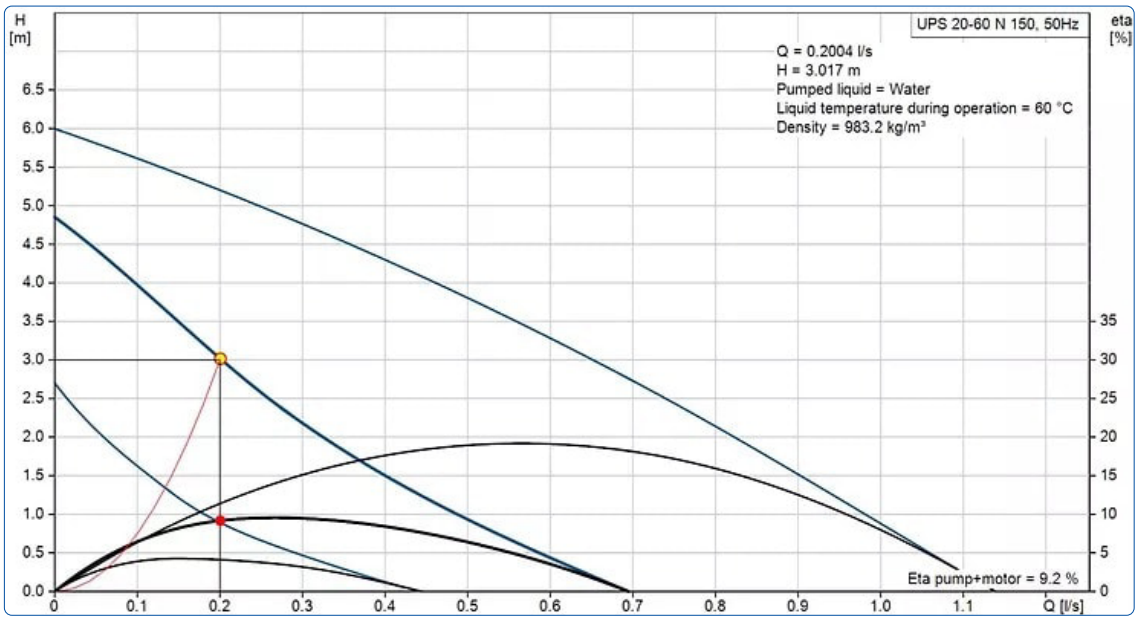


Figure 20. ***Example recirculation pump curve graph Source: Grundfos***

What configurations should the return pump be?

There are various arrangements of recirculation pumps that can be designed and installed; many installations will have more than one pump in the return line for a variety of reasons. Simple pump terminology for return pump configurations is provided in Figure 21 below.

Pump Terminology	
Type	**Explanation**
Duty Pump	The duty pump is capable of supplying the system with the required flow and pressure under most scenarios.
Assist Pump	The assist pump supplements the duty pump, sharing the load when the duty pump can't meet the required flow and pressure.
Standby Pump	The standby pump is a backup to the duty pump, with the same pressure and flow capabilities. The duty and standby pumps switch over regularly to ensure there is equal wear on each.

Figure 21. ***Pump Terminology. Source: PHC***

Whilst there are various configurations of these pump types, the most common are the two below:

- **Duty**

  Only one pump is installed: this is suitable for projects where minimal cost is important and downtime due to maintenance is not an issue. This might be suitable for a house, for example, but it would be pointless in a hospital's 24/7 operation.

- **Duty/Standby**

  Two pumps are installed; this is suitable for most projects as it is still relatively cost-effective. The arrangement provides redundancy during periods of maintenance.

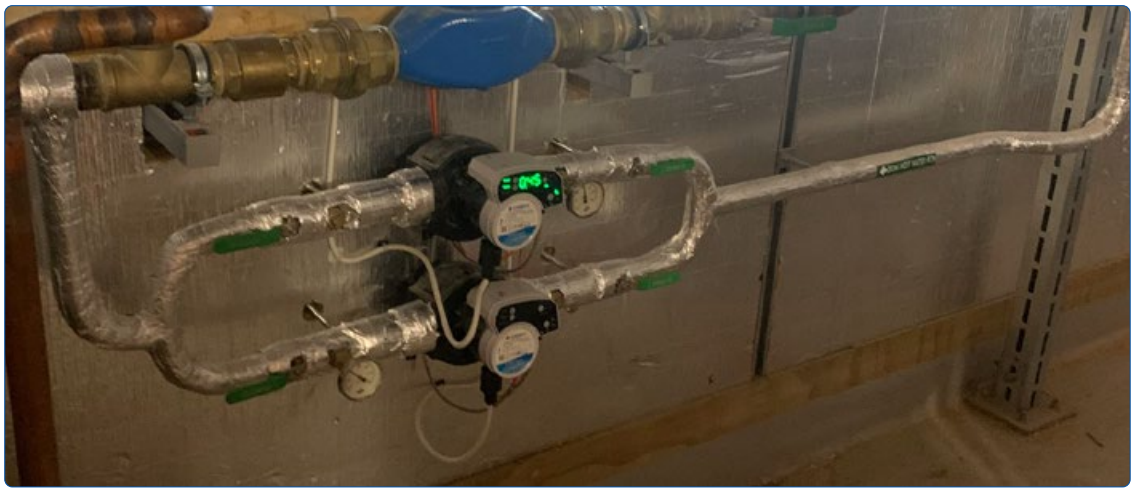


Figure 22. ***Example of duty/standby pump configuration Source: Grundfos***

Air elimination

Automatic air vents are a vital component in today's modern plumbing systems.

Trapped air in circulatory heated water pipe systems is problematic and can lead to increased corrosion of pipes as well as causing column separation, which results in water hammer, pressure surges and cavitation.

Piping should be designed and installed so that entrapped air is automatically removed, and pipes are sized to minimize the effect of pressure shock.

The use of an automatic air vent improves the circulation of the hot water ring main by eliminating air and any other non-condensable gas which may collect at high points in the system.

AS/NZS 3500.4 Clause 10.8.1 states that:

All circulatory heated water piping shall be designed and installed with air elimination valves to eliminate air that can become entrained.

Clause 10.8.2 further states that these valves are to be installed at:

- the highest point or points of the circulatory piping
- on the secondary flow adjacent to the water heater or bank of water heaters
- in an accessible location, and
- with a connected drain delivering over a tundish.

Remember, these valves must be installed into your hot water ring mains systems; without these devices you are potentially reducing the working life of the hot water ring main system.

Figure 23 provides some examples of different styles of air elimination valves.



Figure 23. ***Automatic air vent valves. Source: PHC***

Balancing the system

One of the most common plumbing system issues shortly after occupancy is inadequate water temperature at a fixture or in a general area.

Practitioners called into solve the issue often have their own ideas about what's causing this problem: the water heater temperature is set too low, the circulating pumps are sized too small, the booster pump's pressure is set too low … they start tinkering with these components, completely destroying the design intent of the system and potentially initiating the rapid deterioration of the hot water system's components and pipe materials.

The root cause is simply that the system is "unbalanced."

Balancing valves are used to create equal pressure loss through all parts of the system (once the flow rates through each circuit are known) and the correct commissioning of the balancing valves is a critical aspect of the total system function; poor commissioning generally leads to poor results and system failures down track.

Without balancing valves the water will simply take the path of least resistance, and the system will be unbalanced – with multiple cold spots and, no doubt, customer complaints. (Figure 24 provides good and bad examples.)

In a circulating ring main system where there are multiple sub loops, balancing the system becomes a very important exercise.

Some advantages of a properly balanced circulation heated water system are:

- a reduction in heated water production cost
- a reduction in water consumption
- reducing the waiting time for heated water to reach the tap outlet
- provision of equal temperature throughout the pipework and to outlets
- thermal disinfection throughout the total pipework system.

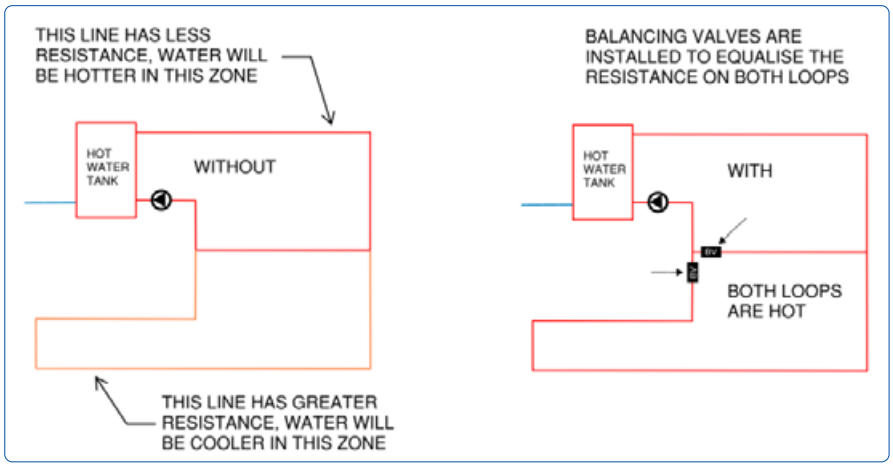


Figure 24. ***Balanced and unbalanced system. Source: PHC***

Choosing the type of balancing valve is usually done during the design phase. The system's complexity will determine the most suitable balancing valve.

In multistorey buildings, the distribution of hot water presents challenges due to heat loss and varying distances between fixtures. In theory, recirculating (pumping) hot water continuously ensures delivery to all fixtures in the building and reduces water waste.

However, it doesn't guarantee uniform hot water throughout a building because water follows the path of least resistance. Balancing ensures that flow is properly distributed across all branches of a hot water system and is accomplished with the use of balancing valves.

These valves regulate flow to compensate for heat loss, with closer branches requiring less flow and farther branches needing more, providing consistent performance throughout the system.

The three most commonly seen types of valves are presented in Figure 25.

Types of balancing valves		
Type	**Picture**	**Comments**
Manually adjustable type		These valves are manually adjusted during commissioning to achieve the flows calculated by the engineer.
Automatic Fixed Flow		These valves automatically adjust loop losses with changes in hot water demand but never deviate from the flow they are set to.
Thermostatic type		These valves adjust the flow with changes in hot water demand to deliver a constant water temperature at their outlet.

Figure 25. ***Balanced and unbalanced system Source: PHC***

Hot water system diagram

When using G12/AS3 (AS/NZS 3500.4) as a means of compliance with the building code, section 9.5 requires a system diagram to be provided and located near the return pumps or hot water plant.

This applies to Class 2 to Class 9 buildings: essentially every building except for a standalone domestic residential house.

However, good practice will include one for standard domestic residential houses as well.

Where a circulating heated water system is installed, there shall be a water fade and weather resistant diagram/s that conform with the following:

- A diagram shall be permanently affixed in a prominent location to the circulating pump/s
- The diagram shall be no less than A3 in size
- The diagram shall display a diagrammatic layout of the circulatory heated water system (and plant) with the diagram, showing the following as a minimum:
    - pipe sizes
    - incoming pressure
    - expansion valves, vessels make/models and KW rating
    - hot water plant temperature setting
    - hot water temperature setting of the master tempering valve
    - circulation pump setting, including set flow/velocity after commissioning
    - balancing valves (if any), size type, location, etc
    - pipe material
    - location of isolation valves
    - location of expansion loops
    - location of air release valves.

The diagram must also include the following information:

- the year of installation
- the name of the contractor who installed the system
- the name of the commissioning agent (if any) who commissioned the system.

On completion, an electronic copy shall be provided to the owner/occupier of the building.

An example of a diagram is provided in Figure 26.

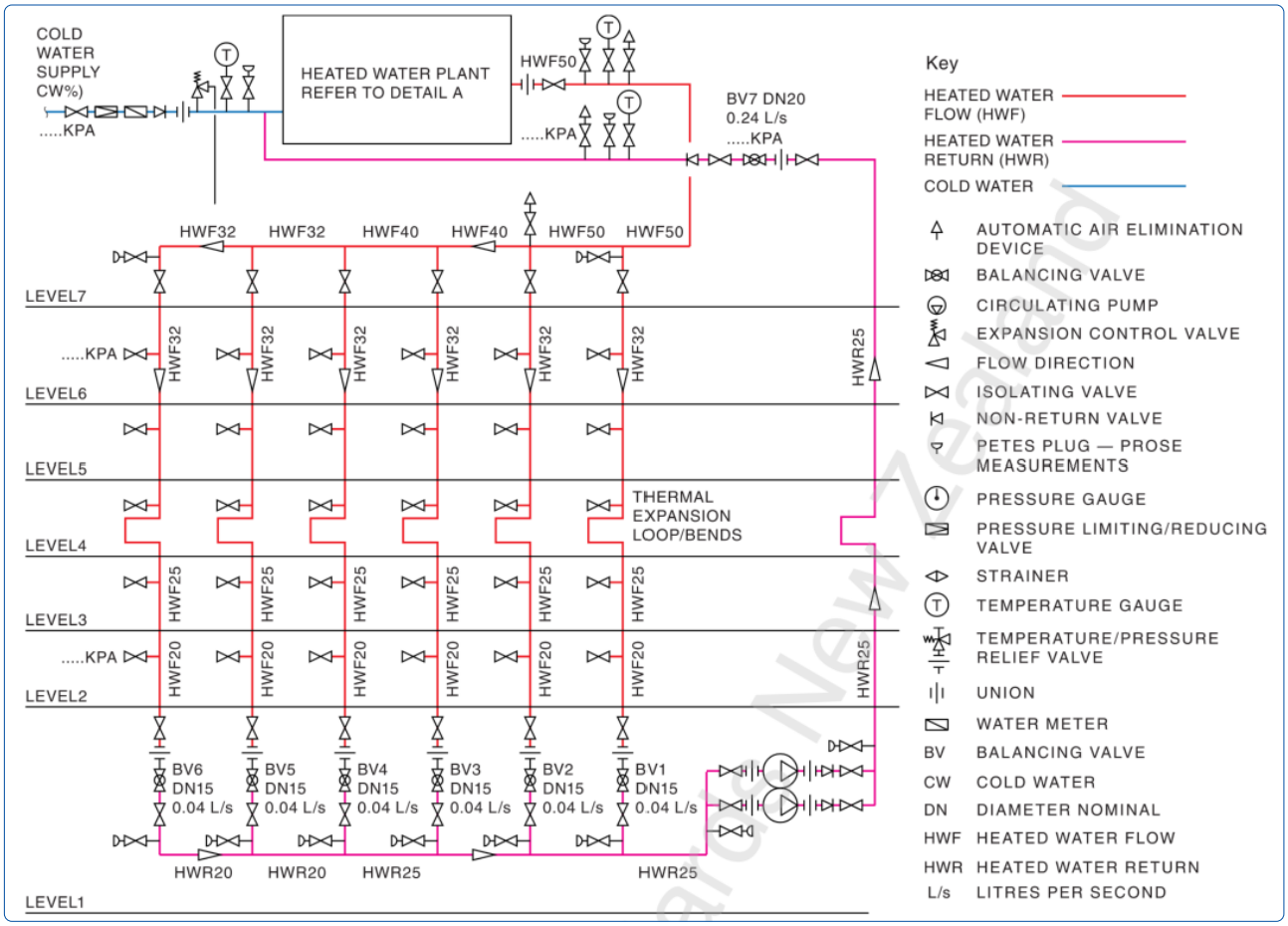


Figure 26. ***Example of hot water circuit diagram. Source: G12/AS3 (AS/NZS 3500.4)***

Conclusion

Hot water ring mains are complex systems with many parts, all with different functions and requirements. Getting any one of those functions or requirements wrong can have a detrimental effect on the overall system – always remembering, though, that the recirculating pump is the heart of the system, so that if this component starts to fail or operate incorrectly it will impact the system in its entirety.

There are plenty of reasons to consider installing a hot water recirculating ring main system. First and foremost, it saves time. No more standing around waiting for hot water to arrive. This is particularly beneficial in larger buildings where water has to travel a longer distance from the heater to the faucet.

Additionally, hot water recirculating ring main systems can offer significant water savings by reducing the amount of water wasted while waiting for it to heat up. Over time this will provide significant environmental and cost benefits simply by reducing water waste.

The key points to keep in mind about recirculating ring main systems are:

- start with the correct design standard
- select the appropriate pipe material for the situation

- keep the system simple and uncomplicated
- ensure the water temperature delivered from any fixture is safe under all conditions
- ensure that the system does not create conditions favourable for pathogen growth
- velocities are to be kept to a minimum
- size the pump to suit the losses
- use the correct insulation to minimise heat losses
- use balancing valves to suit the layout
- air elimination strategies.

If you are unsure or feel a hot water ring main system is outside of your competencies, seek help from someone who is competent in this field. There is nothing worse than a failed or inefficient hot water ring main system.

Ethics and integrity



Hot water ring mains might look simple on paper, but they're one of the more technical systems a plumber can work on. When they're designed and installed well, they save water, reduce energy use, deliver hot water faster, and help prevent health risks like Legionella. When they're done poorly, they can waste money, damage pipework, create temperature problems, and even put people at risk.

Ethics on the job here is about doing more than just getting the pump running. It means designing to the correct standard, keeping dead legs under control, setting and balancing the system properly, and making sure temperatures are both safe and compliant. It's about choosing the right insulation, selecting the correct pump, managing velocities, and not cutting corners on things like air vents or system diagrams.

Taking the time to get a hot water ring main right shows real professionalism. It protects the client, saves them money long term, and keeps the system safe and reliable. That's what doing the right thing on the job looks like.

05

Topic 05:
Testing and commissioning gas appliances

This topic provides information gained from gas appliance suppliers and the wider gas industry about why gas appliances need testing and commissioning, and what benefits this may have for you and your customers.

Written by:

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Introduction

Currently not every member of our industry performs thorough testing and commissioning. But compare these two handoffs to the customer:

a) "I have completed the testing/commissioning and the system is working exactly as the manufacturer says it should. Here are your instructions – call me any time for advice. We'll see you in a year to do a service check."

Or

b) "I've finished the job. Here's my invoice; any problems, call the 0800 number on the back of the instructions for assistance."

Which is most likely to build relationship, show professionalism and lead to repeat work and glowing testimonials?



Figure 1. ***Gas appliance servicing. Source AI generated***

Correct testing and commissioning prevents call backs, customer complaints about you or your work, and (most importantly) developing a bad reputation in the gas industry.

In this topic we will learn the reasons why we should test and commission, the compliance requirements for testing and commissioning, and finally the benefits of testing and commissioning.

By the end of this session you will have gained reasons why you should do this part of the work, and the confidence to explain its benefits to the customer.

Why test and commission gas appliances?

Correct testing and commissioning mean you have met the regulatory and manufacturer's requirements, which is what any practitioner should do. But most importantly, it's part of how you ensure gas appliances are safe to use.

Manufacturers provide information to enable you to correctly commission their appliances. For example:

- Rinnai provides instructions on how to test and commission their appliances, along with a commissioning checklist which they ask you to sign, date and give to the homeowner.
- Rheem also provides 10 pages of the installation manual to assist you in commissioning their gas appliances.

Remember that for hot water it's not only the gas appliance, but the whole system that needs commissioning. The hot water system the gas appliance feeds into could have been designed incorrectly, causing the appliance to fail or perform incorrectly. For example, you should test all hot water taps for correct temperature and flow – some tap aerators on new installations can be blocked, causing a restriction in water flow.

Appliance manufacturers normally state that warranty may be voided and a service charge incurred where they are required to attend a problem related to poor installation.

Gasfitting work that needs testing and commissioning includes pipework, metering, flues, ventilation and appliances.

In conjunction with or in the absence of manufacturer's instructions, follow AS/NZS 5601.1:2013 Appendices O, Q, and R.

Appendix O – Appliance commissioning

There are specific commissioning procedures in the standard for the following appliances:

- stoves, cookers and hotplates
- instantaneous water heaters
- storage water heaters.

Remember to commission the whole system, not just the appliance.

Appendix Q – Gas installation checklist

This appendix contains a useful checklist which includes:

- general requirements
- gas pipework
- appliance installation
- flues
- ventilation
- LPG installations
- commissioning
- certification.

Appendix R – Spillage tests for flued appliances

When testing for spillage ensure all doors and windows are closed, and any air moving equipment is in operation. Essentially you need to create the appliance's worst possible operating conditions. This is also the best opportunity to ensure that any ventilation that has been installed works effectively.

Incorrectly commissioned appliances

Unfortunately, there is a serious side that when incidents happen it can have an immediate impact on the whole industry.

Some appliances when not commissioned correctly can have emissions which include water vapour, nitrogen dioxide and carbon monoxide. These can be released directly into the room and can make the house damp and become a health issue, especially if there isn't enough fresh air ventilation.

To check the spillage on a gas appliance correctly, take a reading before the downdraught diverter. The sample should not be mixed with air in the room. This can be difficult to achieve with the design of some appliances. Read the manufacturer's instruction for the correct procedure.

To check for background levels CO/CO_2 in a room use a suitable CO or CO/CO_2 detector.

What should I check?

- CO/CO_2 (carbon dioxide) concentrations in all gas appliances after installation and after maintenance.
- Background levels for CO/CO_2 in any rooms where customers complain about smell or feeling unwell when using the gas appliance.
- Appliance settings and ratings.
- Appliance condition.
- Ventilation. Remember to check for downdraught when any mechanical ventilation is used.
- Flue system.

What is tolerable?

- An increase in carbon monoxide (CO) from background levels.
- An increase in carbon dioxide (CO_2) from background levels.
- A decrease in Oxygen (O_2) from background levels.

Over-pressure protection

Over-pressure protection is your responsibility: you must supply adequate protection before an appliance if it can't withstand the inlet pressure. In most cases, where an over-pressure device is fitted at the gas meter, the maximum over-pressure at the gas meter outlet is 7kPa for natural gas and 14kPa for LPG.

Piping and components must be able to withstand the maximum pressure likely to occur when the next upstream regulator fails.

Note the maximum inlet pressure to a water heater.



Figure 2. ***Inlet gas pressure rating for a Rinnai Infinity. Source: D Whitfield***

Pressure testing

To carry out tests, you first need an understanding of gas pressures in the system. Rated working pressure is the maximum allowable inlet pressure of any gas appliance or pipe fitting, or any section of pipework.

Appendix E of AS/NZS 5601 provides information about the testing procedure for small-volume gas installations up to 30 litres. Table D1 lets you calculate the approximate volume in litres per minute of pipework in various materials with nominal sizes from 15 to 110 DN.

NOTE: Remember for caravans and boats there is no loss of pressure allowed on any of the tests – everything must be gastight.

Test type	Pressure loss	Time 1	Time 2
Pipework test 7kPa or 1.5 times the operating pressure	No pressure loss	2-minute temperature stabilisation period	5-minute test period
Installation test 2.0kPa or the operating pressure, whichever is greater	No pressure loss	2-minute temperature stabilisation period	5-minute test period
Leakage test 2.0kPa or the operating pressure, whichever is greater	Best practice is no pressure loss*	2-minute temperature stabilisation period	5-minute test period
Additional test for LPG with a pressure-relief device Test pressure equal to the relief setting	No pressure loss	2-minute temperature stabilisation period	5-minute test period

Figure 3. ***Gas pressures tests taken from AS/NZS 5601.1 tabulated. Source D: Whitfield***

* Best practice is no pressure loss, but AS/NZS 5601.1 does permit an allowable pressure loss for existing Installations depending on the volume of the installation.

Summary

Is this required? Yes — these are mandatory requirements.

Work in a logical way – for example, start at the gas meter or cylinders and work your way through the installation. There is nothing worse than struggling with an appliance issue because you've failed to realise that the gas supply is causing it (same goes for electricity).



Figure 4. ***Gas measurement system. Source: D Whitfield***

Make sure you have suitable testing equipment and procedures; use a commissioning check list; keep records to show you comply with every aspect of AS/NZS 5601.

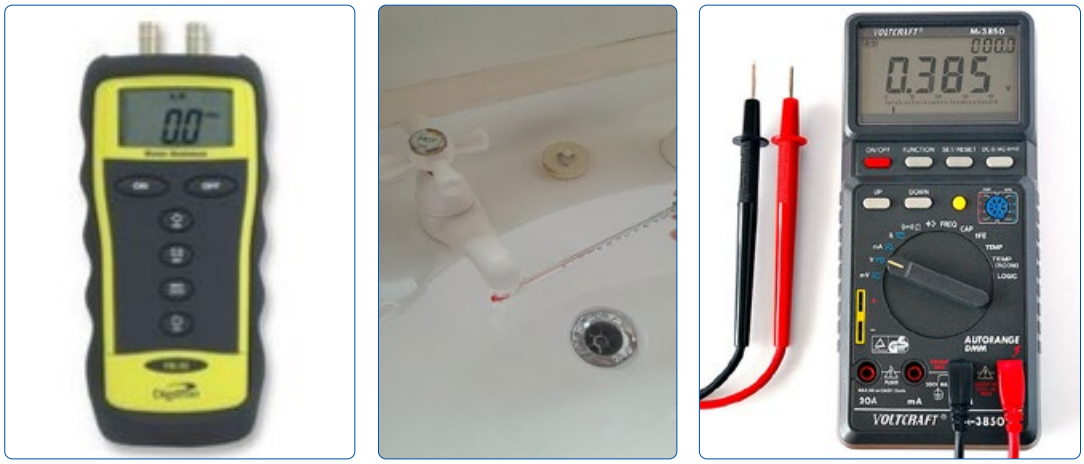


Figure 5. ***Left to right – Digital manometer. Thermometer. Electrical multimeter. Source: D Whitfield***

Compliance requirements for testing and commissioning

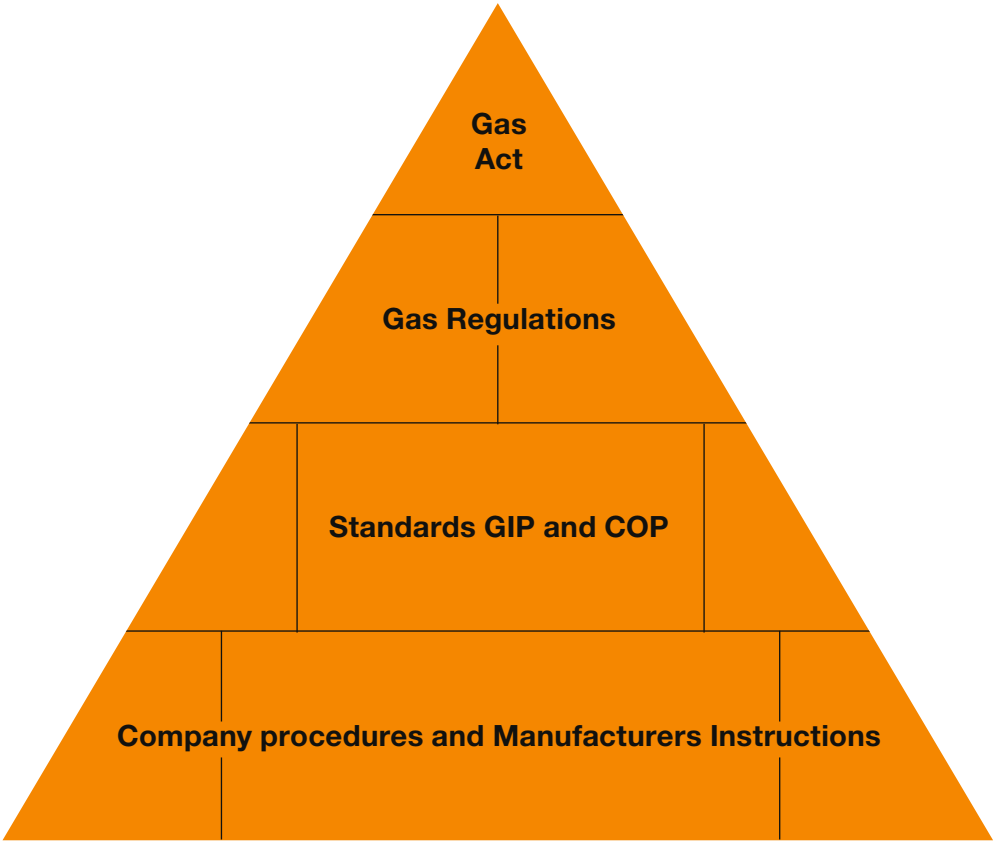


Figure 6. ***Hierarchy of compliance. Source: D Whitfield***

There's several compliance reasons why you must test and commission your gas installations, and it all starts at the top of the legislation pyramid.

Gas Act 1992, section 47: Where any gasfitting work is carried out the gas installation or gas appliance shall not be connected to a gas supply until gas testing/certification has been completed.

Plumbers, Gasfitters, and Drainlayers Act 2006, section 5: Gasfitting definition includes the work of commissioning any gas installation.

Gas (Safety and Measurement) Regulations 2010, regulation 45: All gasfitting work done on a gas installation or part installation must be tested.

AS/NZS 5601, clause 2.2.8 Every gas installation shall be commissioned.

Manufacturer's instructions include commissioning; you should have procedures for doing this.

The above legislation is a snapshot and is a way of making you do this, but don't let that be your only driver.

Summary

Testing and commissioning must be part of our work routine, embedded in your gas installation processes.

Depending on the size of the installation, the commissioning process can take an hour or longer. Allow for the time to do this properly when designing or pricing the job.

For every installation, use a commissioning checklist that follows a logical order – the checklist in Appendix O ASNZS5601.1.2013 is a good place to start.

Remember, the appliance is just one part of the installation to be tested and commissioned – the pipework, gas supply and other regulators or components also need to be considered.

By keeping a record of every job you do you will have proof that you have met your compliance requirements. Providing your customers with copies of documentation such as commissioning sheets, warranties, annual service checklist and of course gas certificates, will also enhance your professional credibility.

Think of it this way: a WOF for a car is compulsory if you want to drive it on the road and meet the legislative requirements. Would you run a risk if you don't have one? Would your insurance company pay out if something went wrong and you needed repairs carried out? Do you always expect the WOF checklist as verification it's been done?



Figure 7. *Show the card*

Benefits of testing and commissioning

For the customer it means:

You provide customer confidence; you let them know you have done it right. It gives them peace of mind, makes them feel safe and assures them that they have got value for money.

For you it means:

You are legally compliant as well as fulfilling any quality assurance processes you operate; it demonstrates your differentiated service, it gives you peace of mind, and it's what you should do.

Things to consider

You might be busy, and gasfitting may not be your core work, meaning a gas hot water install is the only gasfitting you do. But the obligations are the same, regardless of how often you undertake that work.

If you don't have the capacity to test and commission gas appliances, you should partner with someone who can. If gasfitting is becoming a larger part of your business, it may be more practical to train or employ someone with the right capability.

Doing the job right the first time also has broader benefits. It builds trust, leads to word-of-mouth referrals, and can generate ongoing work—not just for gas, but for maintenance and plumbing as well.

Summary

Gas appliances are safe when they are regularly maintained; technically, gas appliances should also work more efficiently if they are well maintained.

Regular servicing can identify parts that are worn and may need replacement or repair at less cost than replacing the appliance if it is left to become a bigger problem.

Some appliance suppliers require regular maintenance for the warranty to remain valid; some insurance companies may also require gas appliances to be regularly serviced as a condition of their policies.

Commissioning to manufacturer's instructions means the appliance should do what it's designed to do.

Conclusion

Give your customers confidence by letting them know you have done it right. Testing and commissioning their appliances gives them peace of mind, makes them feel safe, and helps them feel that they have got value for money.

Stay compliant: the last thing you need is a professional blemish on you and your business. Ask questions if you are unsure. Technical advice is free.

Start now, get your checklists in place, get your testing equipment calibrated. Read up in other areas for tips on testing and commissioning.

Some appliance suppliers have online training, and others do appliance roadshows. These are valuable resources to tap into.

Do it right. Every time. No exceptions.

Ethics and integrity



Installing a gas appliance is only part of the job. Knowing it has been properly tested, commissioned, and handed over with confidence is what defines professional gasfitting. Ethical practice means not walking away once the appliance fires up, but staying long enough to confirm it is operating as designed, under real conditions, and as part of the wider system it belongs to.

Testing and commissioning show pride in workmanship. They reduce callbacks, prevent avoidable faults, and give customers confidence that their appliance has been set up by someone who knows what they're doing. When gasfitters take the time to test thoroughly, document results, and explain what's been done, they set themselves apart as trusted professionals, not just installers. Done consistently, commissioning protects reputations, strengthens customer relationships, and supports the longterm credibility of the trade.

Notes

Plumbers,
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