ABCB

National Construction Code

Handbook

Warm water systems

2020

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Preface

The Inter-Government Agreement (IGA) that governs the Australian Building Codes Board (ABCB) places a strong emphasis on reducing reliance on regulation, including consideration of non-regulatory alternatives such as non-mandatory handbooks and protocols.

This Handbook is one of a series produced by the ABCB developed in response to comments and concerns expressed by government, industry and the community that relate to the built environment. The topics of Handbooks expand on areas of existing regulation or relate to topics which have, for a variety of reasons, been deemed inappropriate for regulation. They provide non-mandatory advice and guidance.

The Handbook assists in understanding the process a designer would use in the development of a warm water system, through information sourced from Commonwealth, State and Territory regulatory and advisory publications, manufacturers' technical material and the National Construction Code (NCC) Volume Three – The Plumbing Code of Australia (PCA). It addresses issues in generic terms, and is not a document that sets out a complete reference for the design, installation and maintenance of such systems. It is expected that this Handbook will be used to guide solutions relevant to specific situations in accordance with the generic principles and criteria contained herein.

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REMINDER

This Handbook is not mandatory or regulatory in nature and compliance with it will not necessarily discharge a user's legal obligations. The Handbook should only be read and used subject to, and in conjunction with, the general disclaimer at page i.

The Handbook also needs to be read in conjunction with the relevant legislation of the appropriate State or Territory. It is written in generic terms and it is not intended that the content of the Handbook counteract or conflict with the legislative requirements, any references in legal documents, any handbooks issued by the Administration or any directives by the Appropriate Authority.

1 Background

The National Construction Code (NCC) is a performance-based code containing all Performance Requirements for the construction of buildings. A building, plumbing or drainage solution will comply with the NCC if it satisfies the Performance Requirements, which are the mandatory requirements of the NCC.

As part of the ABCB's 2014-15 work program, the Plumbing Code Development Research Report – Warm Water Systems was delivered. The report provided a study of current design, installation and maintenance practices for warm water systems. It identified similarities in technical details within a range of literature reviewed but also highlighted variations in relevant plumbing regulatory controls. It also found that some States and Territories develop their own codes for reference within their respective health regulations, some being prescriptive and some risk-based.

Following an extensive consultation process the report recommended the delivery of this Handbook to provide guidance to practitioners seeking to demonstrate compliance with the Water Services requirements of NCC Volume Three, Section B.

1.1 Scope

This Handbook contains general information on the design, installation and maintenance of warm water systems. It includes system design options, temperature control measures, bacterial control considerations, and applicable State and Territory regulation and guidance material.

1.2 Using this document

General information about complying with the NCC and responsibilities for building and plumbing regulation are provided in Appendix A of this Handbook.

Acronyms and symbols used in this Handbook are provided in Appendix B.

Defined terms are used in this Handbook. They may align with a defined term in the NCC or be defined for the purpose of this Handbook alone. See Appendix C for further information.

References are also provided.

Different styles are used in this Handbook. Examples of these styles are provided below:

NCC extracts

Examples

Alerts

Reminders

2 Heated water services

Heated water services, also known as hot water services, are typically installed in most buildings including circulatory heated water systems that are designed to distribute heated water (hot water) at 60°C or higher.

The technical requirements for the design and construction of heated water services are outlined in NCC Volume Three, the Plumbing Code of Australia (PCA).

Part B2 Heated Water Services sets out the requirements for the design, construction, installation, replacement, repair, alteration and maintenance of any part of a heated water service of a property that is connected to the drinking water supply. It covers from the point of connection to the points of discharge.

The requirements of Part B2 ensure the following:

- sanitary fixtures, sanitary appliances and supply outlets provided with heated water have a safe and adequate piped heated water supply
- the heated water supply is conveyed through plumbing installations in a way that—
    - minimises any adverse impact on building occupants, the Network Utility Operator's infrastructure, property and the environment; and
    - facilitates the conservation of water.
- to reduce greenhouse gas emissions, to the degree necessary, a heated water service—
    - is capable of efficiently using energy; and
    - obtains its heating energy from—
        - a low greenhouse gas intensity energy source; or
        - an on-site renewable energy source; or
        - another process as reclaimed energy.

To meet these objectives, the design and installation of a heated water service must meet the relevant Performance Requirements of Part B2 (see Appendix A). If using a Deemed-to-Satisfy (DtS) Solution, the provisions of the PCA and the documents it references, such as AS/NZS 3500.4, must be complied with.

3 Warm water systems

Warm water systems distribute water to outlets used for personal hygiene purposes such as showers, basins and baths, at a reduced temperature to minimise the risk of scalding. They should not be confused with the 'heated water system' typically installed in most buildings, including circulatory heated water systems that are designed to distribute heated water (hot water) at 60°C or higher, although there are similarities between the two.

Heated water is defined by the PCA as water that has been intentionally heated. It is normally referred to as hot water or warm water, thus the Performance Requirements of Part B2 also apply to warm water systems. There are no DtS Provisions for the design and installation of warm water systems in Part B2 and a Performance Solution must be used to demonstrate compliance with the relevant Performance Requirements of the PCA (see Appendix A). This is highlighted by a note under B2.9, that states, "There are no Deemed-to-Satisfy Provisions for warm water systems".

According to New South Wales Health, warm water for the purpose of scalding minimisation is heated water delivered at temperatures 45°C or less at the outlet, with warm water systems usually operating between 40.5°C and 43.5°C. This is lower than the temperature of water usually provided for personal hygiene purposes, which is a maximum of 45°C in certain high scald-risk situations and 50°C more generally. Although many of the systems discussed in this Handbook could also be used for higher temperatures, the focus in this case is only on warm water systems using lower temperatures.

Warm water systems are commonly used in hospitals, health-care buildings and aged care facilities but they can be installed in a large range of buildings, including residential apartment blocks, accommodation buildings such as hotels and even hairdressing salons. There are two main types of warm water systems; reticulated and centralised circulatory.

As noted above, these systems are generally installed to reduce the likelihood of scalding, but the reduced temperature can also introduce other risks such as microbial growth. Water within a certain temperature range promotes the development of potentially pathogenic microorganisms, including Legionella, if systems are not designed, installed, managed and maintained with this in mind.

The information provided in this Handbook predominantly focuses on those building types mentioned above, i.e. hospitals, health and aged care, but depending on the need, it could also be relevant to other building types.

There are a number of factors to take into consideration when undertaking any work associated with a warm water system, such as system design, installation configurations, ongoing maintenance and State and Territory regulations This Handbook touches on all of these aspects, including jurisdictional regulations, codes and guidelines applicable at the time of publication (see Appendix D).

4 Design

There are many different pipework configurations and heating variants used in the design of warm water systems, with a number of these also used for general purpose heated water installations. Some systems distribute heated water to thermostatic mixing valves (TMV) or tempering valves (TV) that are installed within the room the system serves while others distribute warm water to fixtures at the desired temperature without the use of a TMV or TV. In systems that incorporate temperature control devices (TCD), untempered branches can serve other fixtures not intended for personal hygiene purposes and not requiring temperature control, such as kitchen sinks or laundry sinks. Other designs can distribute water at the desired temperature, circulated around the building and these usually incorporate a means of system disinfection.

Various types of water heating sources are covered in Section 5.2. The design of a warm water system will be affected by many things such as building type, use and layout, heating plant energy source and location, State and Territory plumbing, building and health regulations. One general requirement found in the majority of regulations covering these systems is the need to incorporate a means of disinfecting and draining the system.

4.1 Types of warm water systems

There are generally two types of warm water systems, 'reticulated' and 'circulatory'. Some circulatory systems can include a primary and secondary circulation system that circulates water to and from the heat source (primary), as well as around the building (secondary). They can have a single heat source or multiple heat sources manifolded together to provide a greater heated water capacity. A heat trace system can also be used on pipework to assist in retaining heated water temperatures.

The different system types are described in the following sections with associated figures to assist in their explanation. A glossary of the symbols and abbreviations used in the figures can be found in Appendix B.

There are also proprietary systems available from a number of manufacturers. These systems incorporate various components arranged into a pre-packaged set-up for warm water temperature control. Due to the range of systems and their complexity, this Handbook does not cover them.

4.1.1 Reticulated systems

A reticulated system is where heated water is distributed to one or more sanitary facilities with water temperature regulated via a TMV. This type of system is primarily used where there are a small number of fixtures within the building and the water heater is in close proximity to the outlets. For reticulated systems where the temperature of the water is to be maintained within the pipework, heat trace cables can be installed. Simplified versions of reticulated systems are covered in Section 4.1.1.1 for a single pipe reticulated system and Section 4.1.1.2 for a reticulated system incorporating heat trace cables.

4.1.1.1 Single pipe reticulated system

A single pipe system that distributes heated water to outlets or TCDs. Typical examples are shown at Figure 4.1 and Figure 4.2. This type of system is primarily used in small installations where the water heater can be located in close proximity to the outlets.

Figure 4.1 Typical example of a fully tempered reticulated heated water system

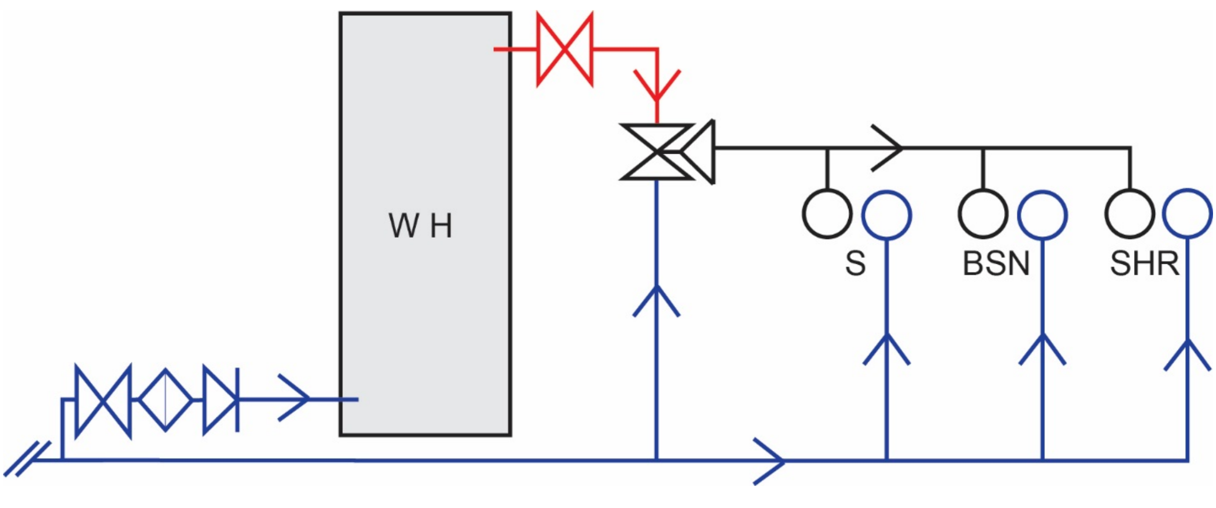
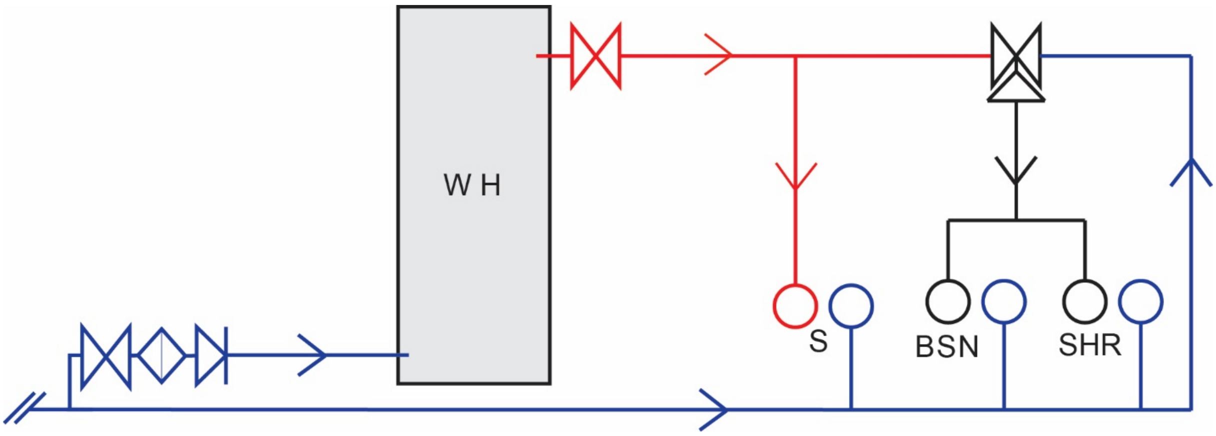


Figure 4.2 Typical example of a partially tempered reticulated heated water system



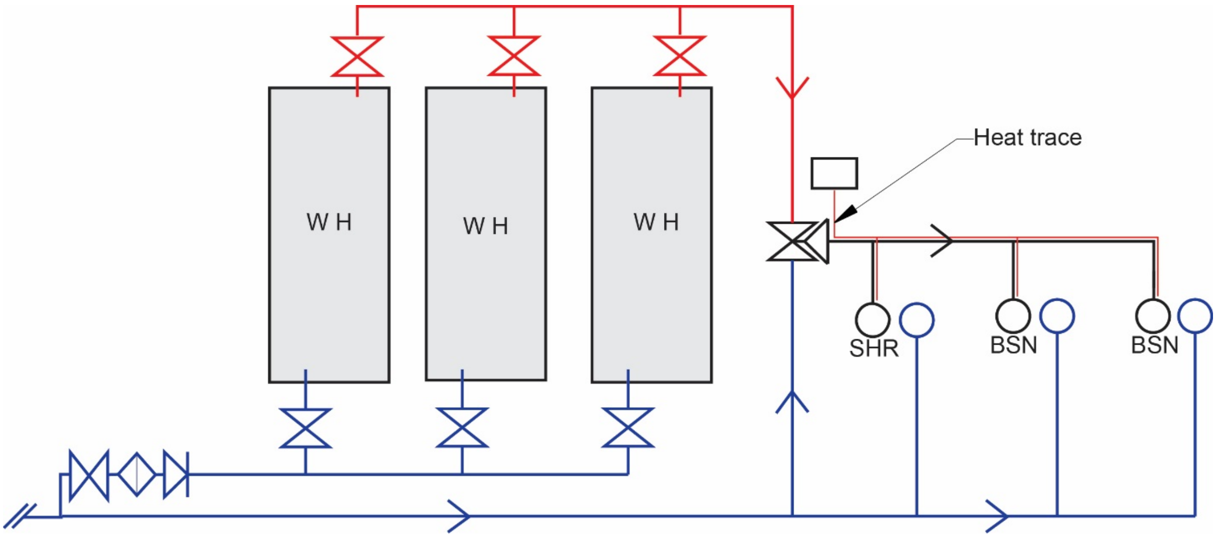
4.1.1.2 Reticulated system incorporating heat trace cables

This is a reticulated system where the water temperature is controlled through TMVs and distributed throughout a building with the water temperature maintained in the pipework by a heat trace cable. Heat trace cables replace heat lost in the heated water pipework to enable a desired temperature to be maintained without the need for recirculation. An example of a heated water system is provided in Figure 4.3 that demonstrates the use of a manifold system along with a heat trace system..

Heat tracing cable should be installed at the lowest point of the pipework and the outer radius of a bend to provide sufficient heating to the water. Labels should be permanently located at regular intervals to advise of its presence. Thermal insulation is recommended to avoid heat losses and mechanical protection such as metal cladding can also be installed. When using this type of system, it is recommended that it be effectively bonded to an earthing conductor.

Generally, the main and branches 20 mm diameter and larger are the primary applications for heat trace systems. A risk assessment should be undertaken when determining if a heat trace system is suitable. Heat trace systems should be installed in accordance with guidance material provided by the system manufacturer.

Figure 4.3 Typical example of a reticulated heated water system incorporating a heat trace



4.1.2 Circulatory systems

A circulatory system maintains a constant temperature by drawing heated water through the system via a pump or pump set. In addition to the typical central circulatory systems shown below there are several other common configurations covered in this section. They include a single pipe circulating systems (see Figure 4.4 and Figure 4.5) or multiple pipe circulating systems with single or multiple circuits.

Figure 4.4 Typical example of a single pipe circulatory warm water system

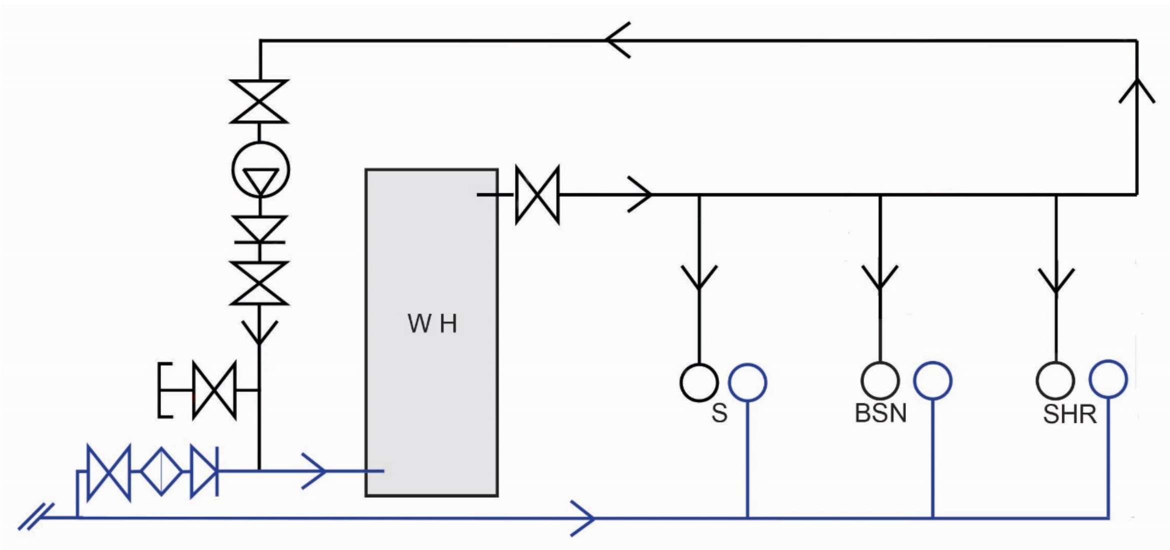
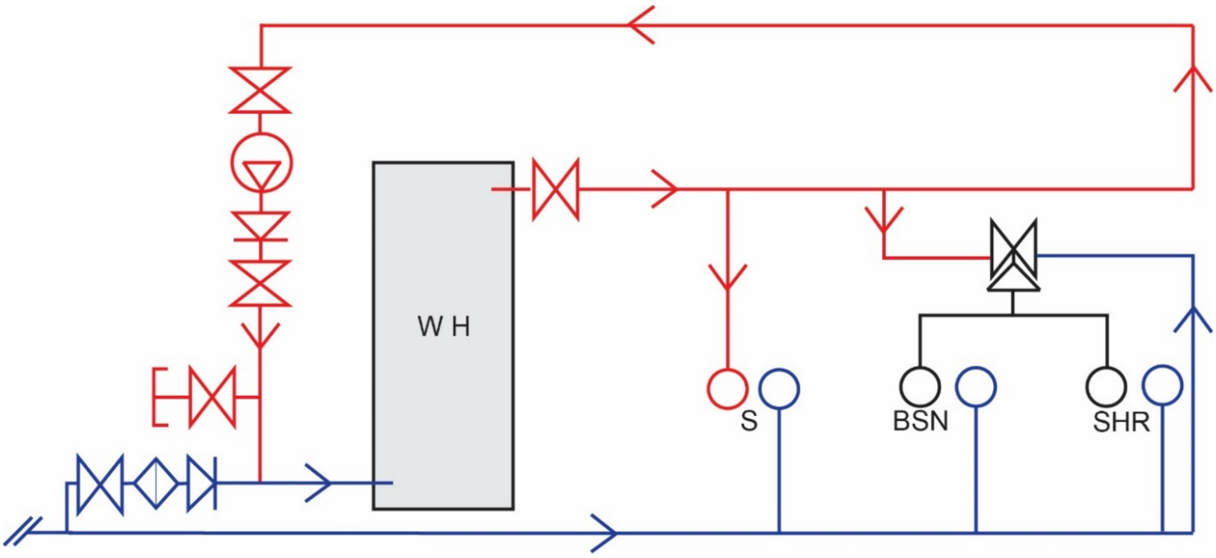


Figure 4.5 Typical example of a single pipe circulatory heated water system



4.1.2.1 Primary and secondary circulating circuits

The secondary circulatory system is fundamentally the same system as a single pipe circulating system circulating heated or warm water around the building. The water is heated by circulating through a heat source on a primary circuit rather than heating the water within the storage containers. Some common examples of these different scenarios are shown in Figure 4.6 using a solar heating source and Figure 4.7 using heating plant such as a boiler. Both examples use TMVs to deliver the desired temperature to the outlet.

Figure 4.6 Typical example of a circulatory system, with primary and secondary circuits using solar as the heating source

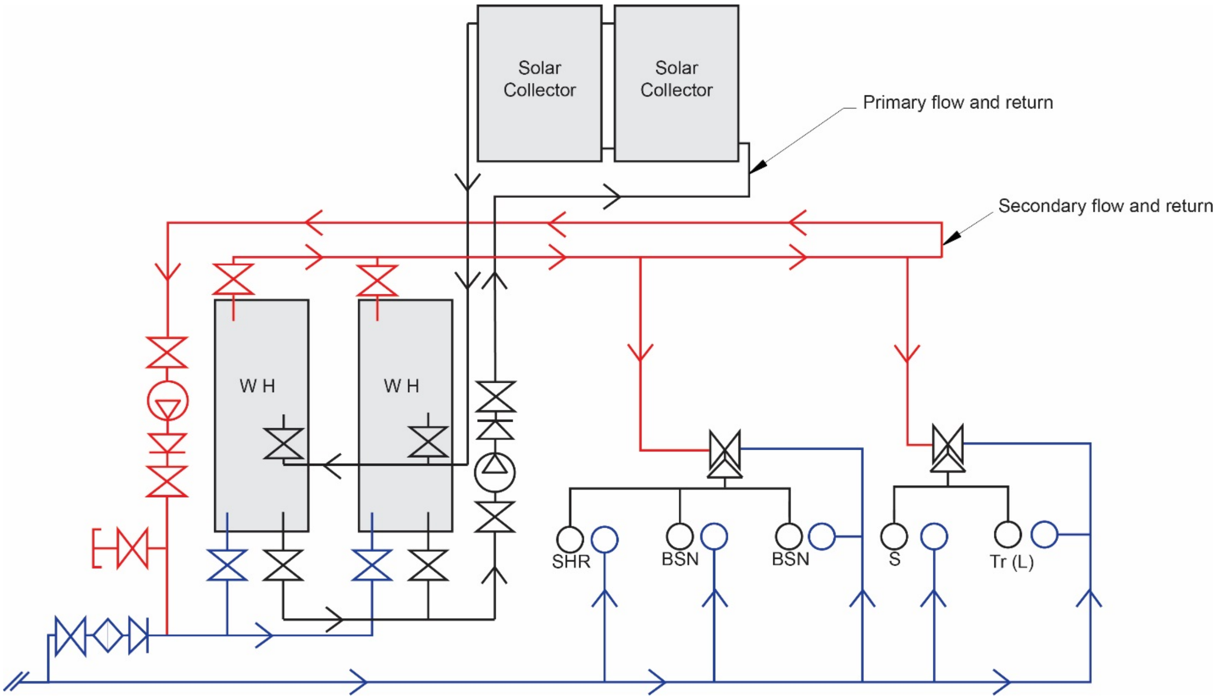
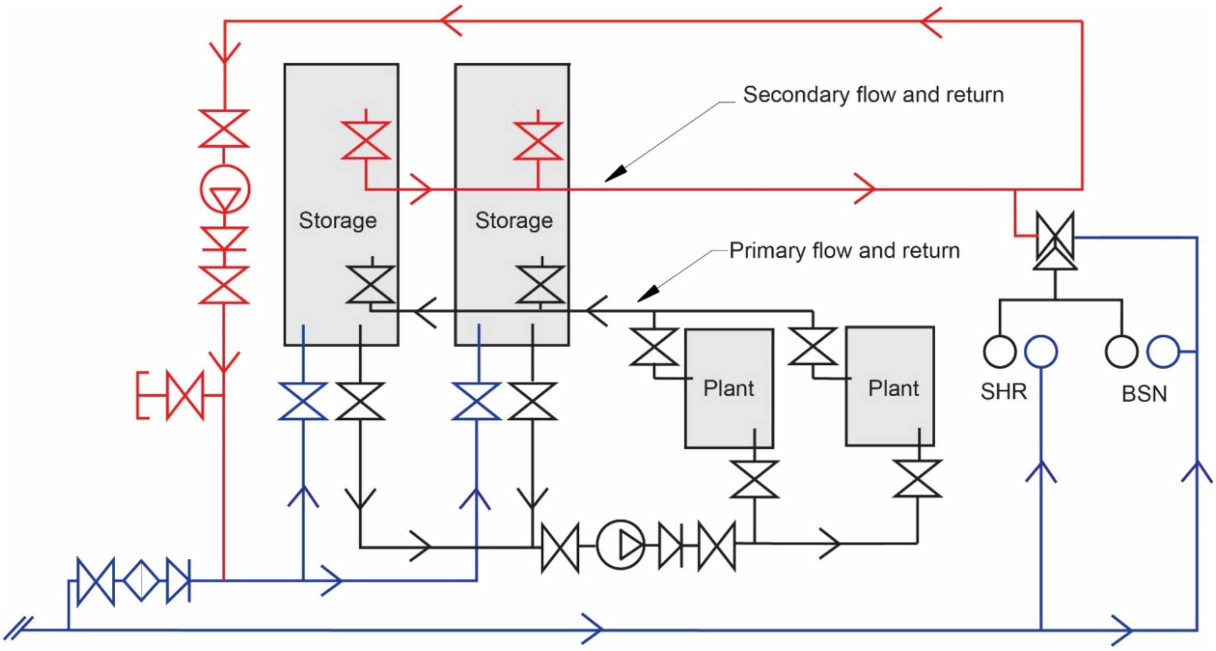


Figure 4.7 Typical example of a circulatory system, with primary and secondary circuits using plant as the heat source



4.1.2.2 Single pipe circulating systems

Single pipe circulating systems are primarily used in commercial buildings and high rise apartments to service a large number of outlets across many levels where a centralised heating plant is used. However the number of outlets being served by this type of system is limited by the size of the pipework and heating plant. These systems incorporate a pump or pump set to circulate heated water throughout the circuit back to the heating plant. To ensure that the flow rate is equal across all branches, balancing valves are used before returning the heated water to the plant.

The return pipe usually has a 3°C to 5°C reduction in temperature depending on the length of the circulatory system. These systems can either be set within warm water limits or use TMVs within close proximity to outlets, reducing the amount of tempered water pipework. The latter approach is shown in the two figures below with pumps installed on the return line shown in Figure 4.8 and Figure 4.9 and with pumps installed on the flow line, shown at Figure 4.10 and Figure 4.11.

Figure 4.8 Typical example of a heated water flow and return system using a single storage water heater with pumps installed on the return line

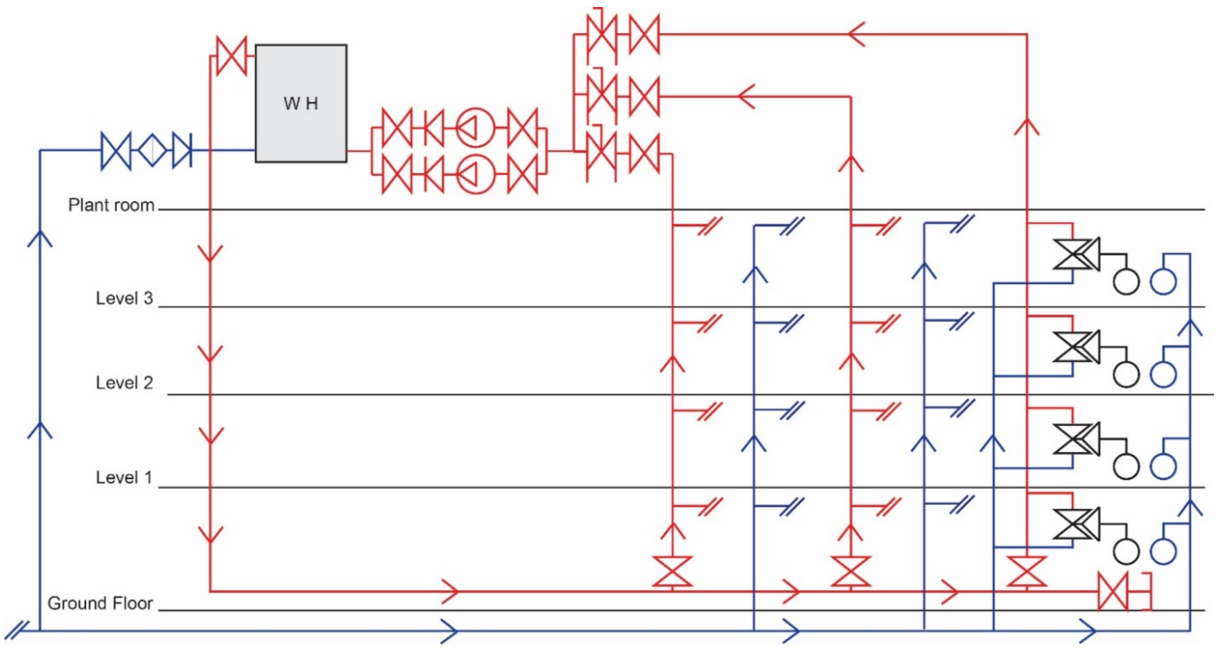


Figure 4.9 Typical example of a warm water flow and return system using a single storage water heater with pumps installed on the return line

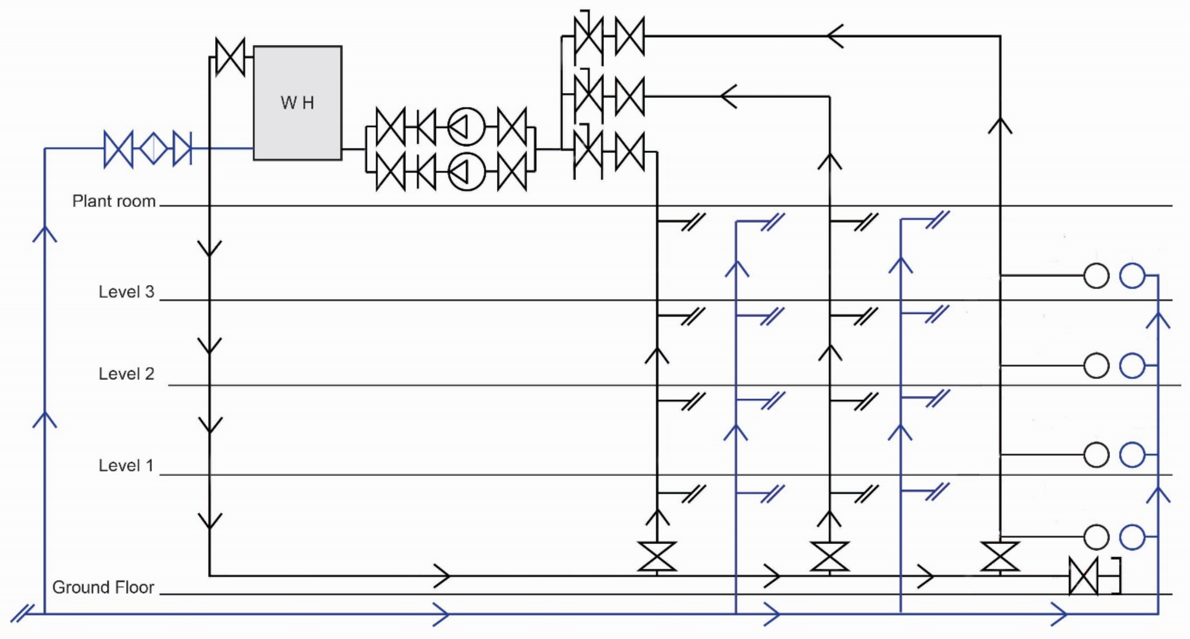


Figure 4.10 Typical example of a heated water flow and return system using a single storage water heater with pumps installed on the flow line

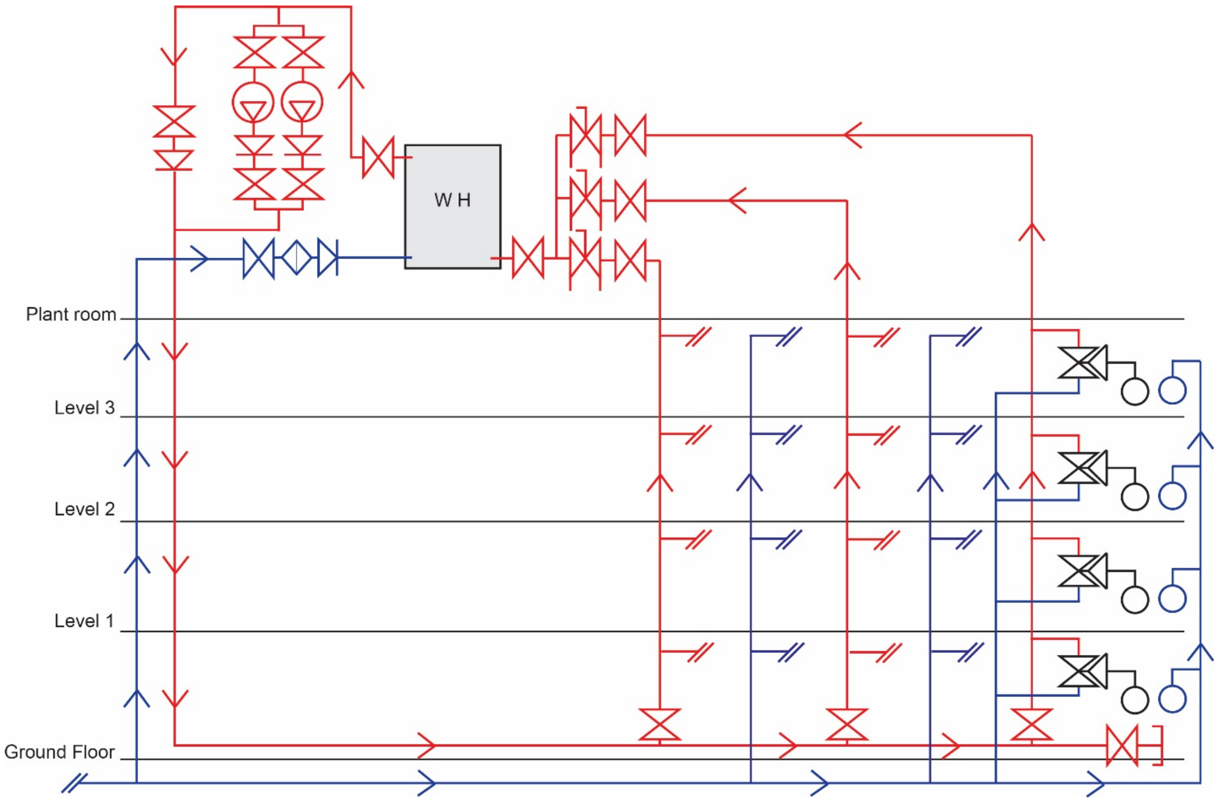
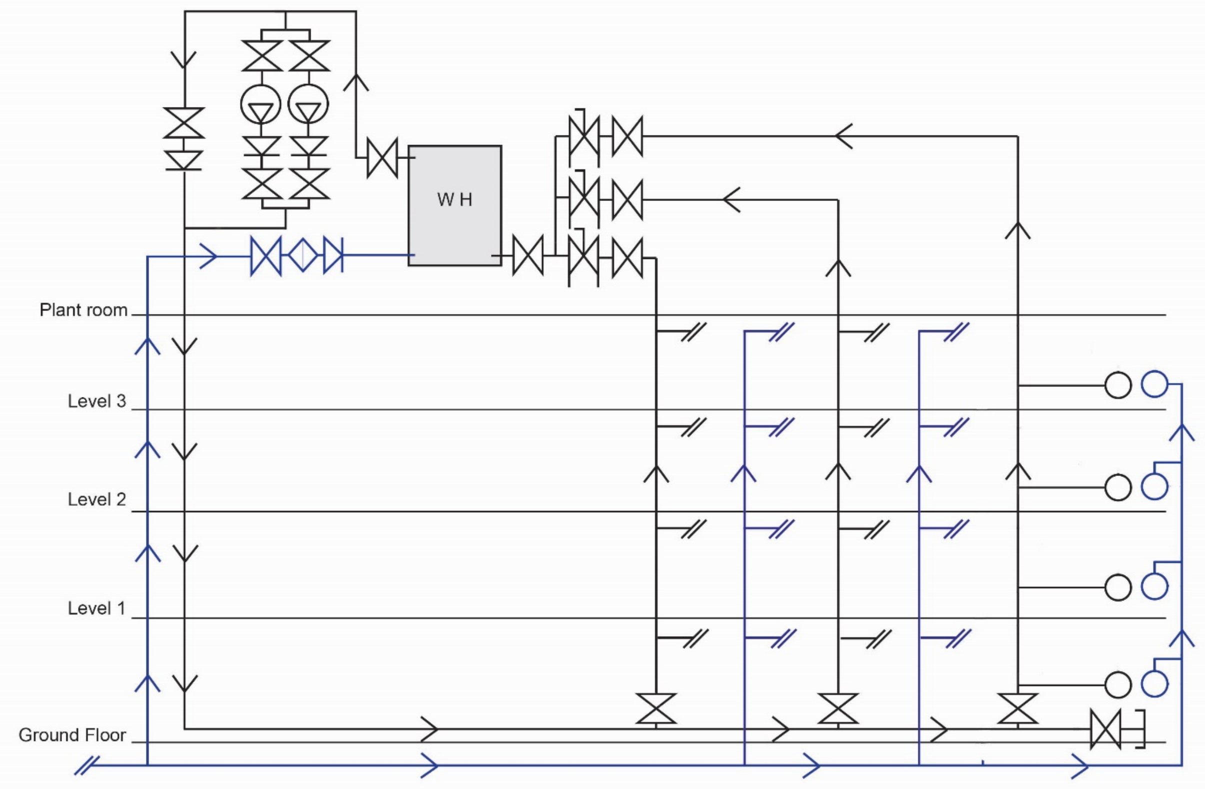


Figure 4.11 Typical example warm water flow and return system using a single storage water heater with pumps installed on the flow line



4.1.2.3 Multiple pipe circulating systems

Multiple pipe circulating systems consist of two main configurations. These are:

- two pipe – direct return systems
- two pipe – reverse return system.

4.1.2.3.1 Two pipe – direct return system

Two pipe direct return systems comprise two main pipes (rings or loops); one delivers the heated water to each level of the building, the other returns the heated water to the water heater, as shown at Figure 4.12 and Figure 4.13. These systems are designed to limit the length of any branches from the circulatory line to a recommended 6 to 8 metres.

Note that bubbles can form when the water is heated within the plant equipment, which can cause an airlock in the system. To prevent this the circuit should extend the return pipework to the highest floor and include an air relief valve at the highest point to expel any air prior to returning to the heating plant by a pump or pump set.

Similar, to a typical flow and return system, these systems use TMVs within close proximity to outlets, reducing the amount of tempered water pipework.

Figure 4.12 Typical example of a heated water two pipe - direct return system through a single storage water heater

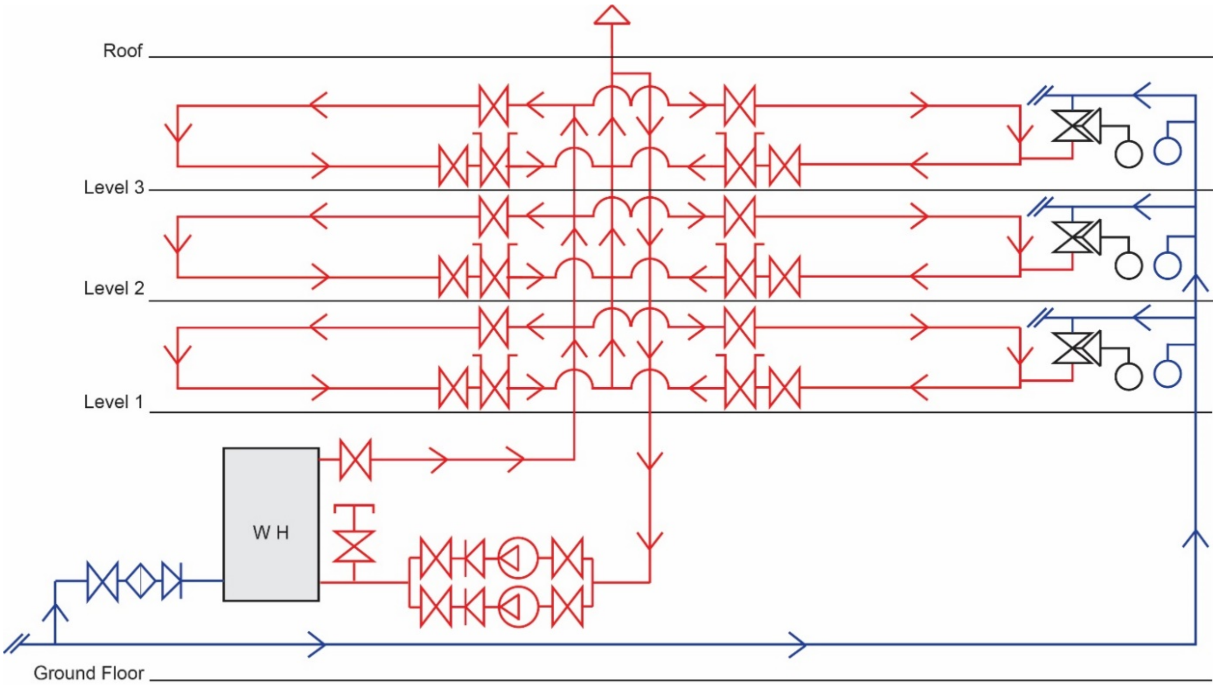
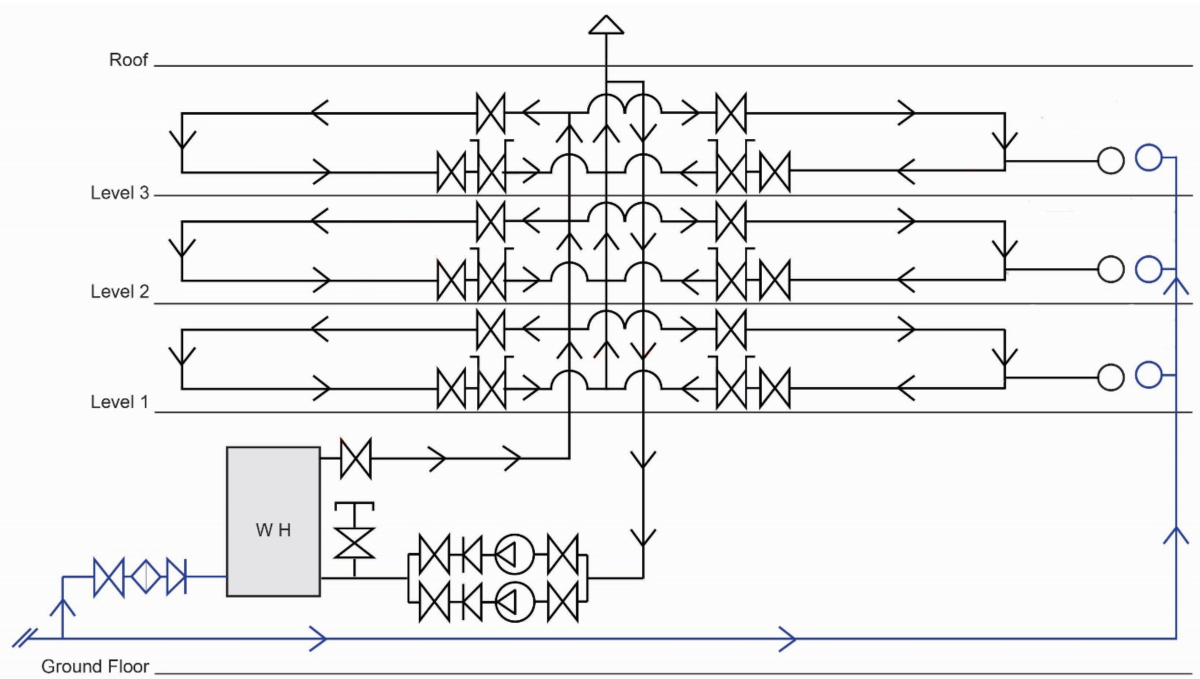


Figure 4.13 Typical example of a warm water two pipe - direct return system through a single storage water heater



4.1.2.3.2 Two pipe – reverse return system

The two pipe reverse return system is also a two pipe heated water system incorporating two main pipes (rings). It is designed to have an even flow to all branches or levels of the system by having equal flow and return pipe lengths. This is achieved by having the first branch off the flow line to the secondary ring of the circuit also being the last to be returned to the return line. Balancing valves are recommended for this type of system to ensure a consistent water flow. These systems can either be set within warm water limits or use TMVs within close proximity to outlets, reducing the amount of tempered water pipework. Examples of this system are shown in Figure 4.14 and Figure 4.15 with a single storage water heater.

Figure 4.14 Typical example of a heated water two pipe - reverse return system through a single storage water heater

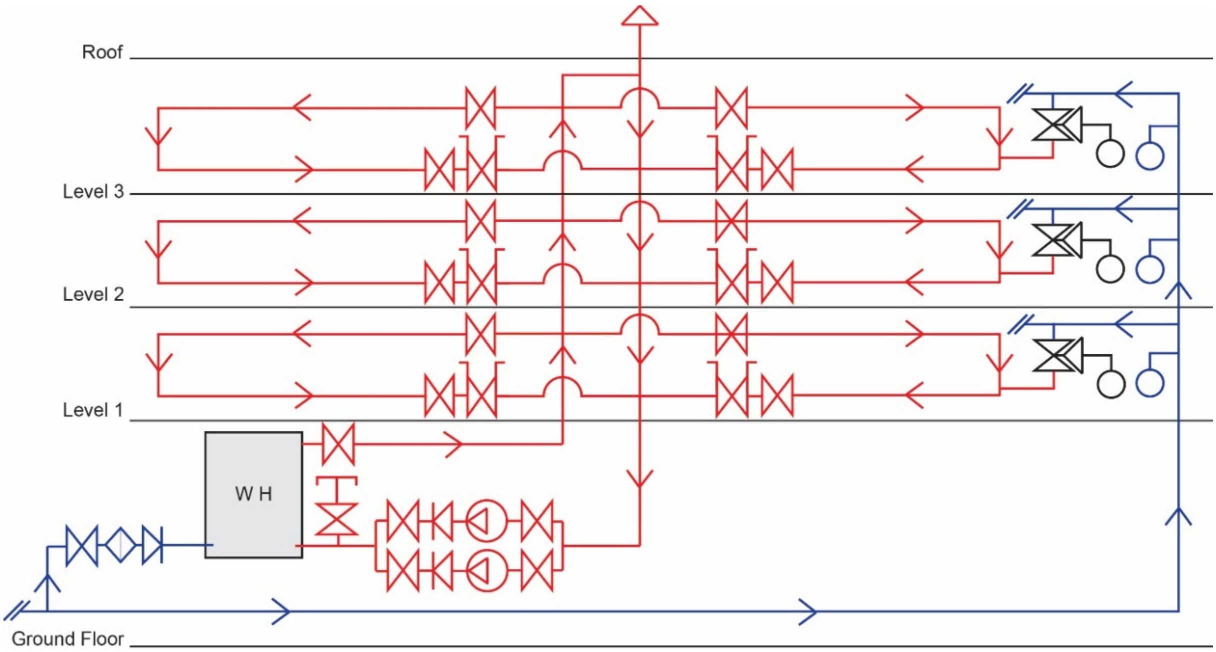
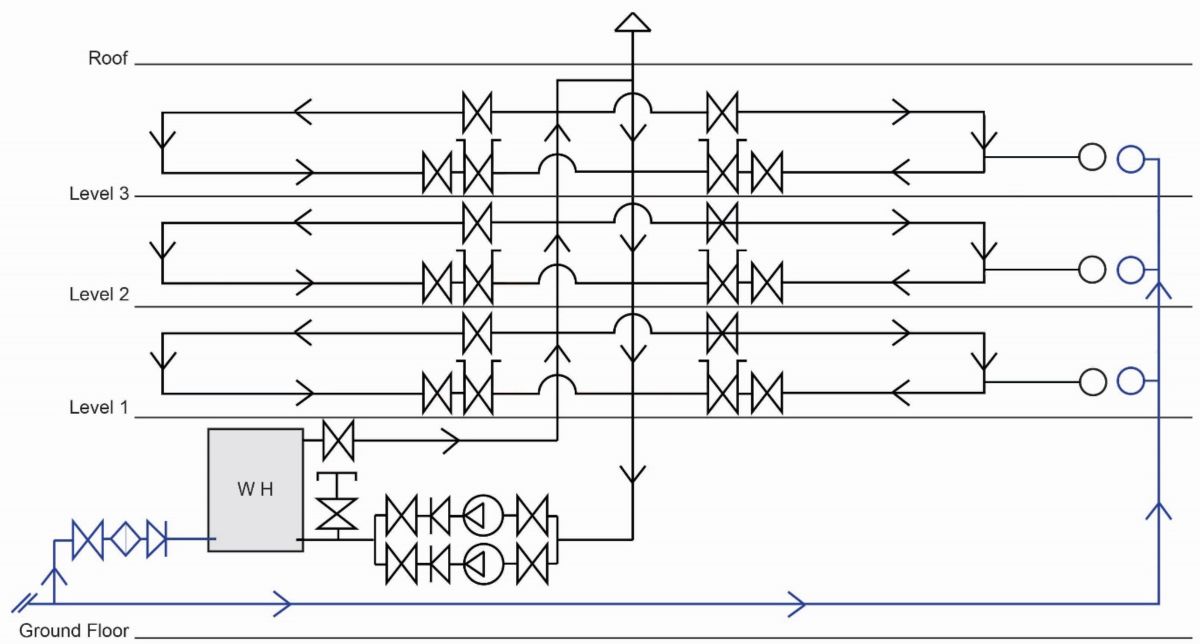


Figure 4.15 Typical example of a warm water two pipe - reverse return system through a single storage water heater



4.2 Temperature control

The water temperature at the outlet is controlled by either:

- a temperature control device (TCD), such as a TV or TMV
  or
- through a temperature sensor.

The following section provides details on these temperature control options.

4.2.1 TCDs

TCDs blend heated and cold water as it passes through a mixing valve set to the required temperature. In the case of a TMV, the valve also provides a thermal shut-off function that causes a thermal shutdown if there is any disruption to the cold or heated water supplies. Examples are shown in Figure 4.16 and Figure 4.17 using a single storage water heater. Reducing the water temperature as close as possible to the outlet also reduces the risk of bacteria growth within the system by maintaining a higher temperature.

Figure 4.16 Typical example of a single pipe circulatory heated water system controlled by a TCD

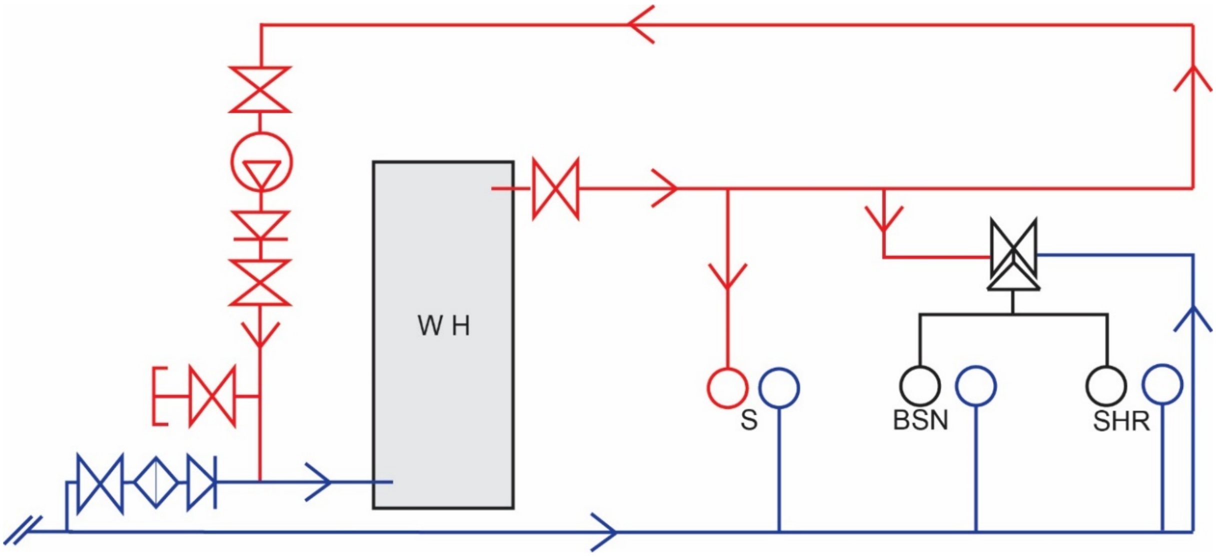
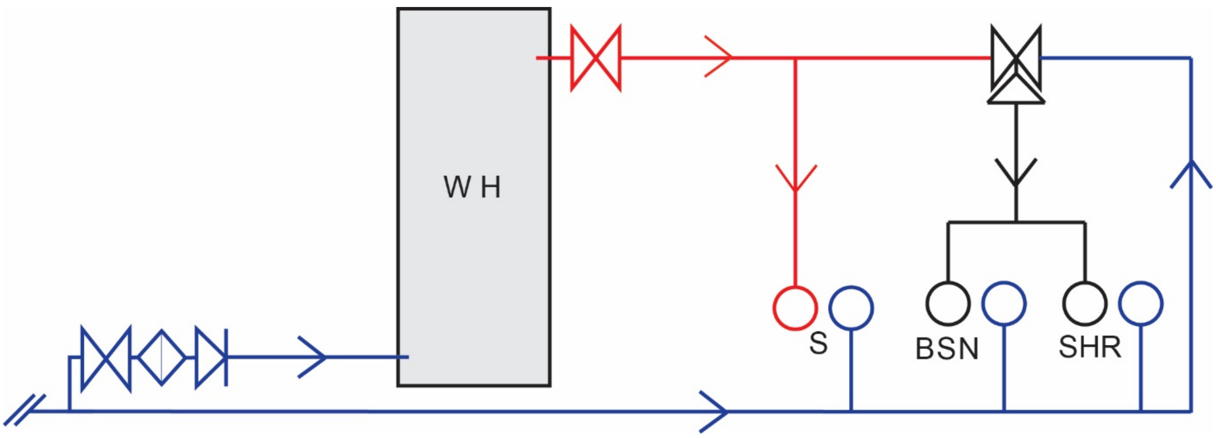


Figure 4.17 Typical example of a reticulated heated water system controlled by a TCD



4.2.2 Temperature sensors

Temperature sensors can be used to digitally monitor and adjust the water temperature. This can be done by continuous flow water heaters, modulating valves or a combination of the two.

Within continuous flow water heaters, sensors monitor the amount of water being drawn and adjust the burner to regulate the water temperature automatically. This is shown in Figure 4.18 with a manifold of continuous water heaters incorporating UV filtration.

Modulating valves regulate the desired water temperature though an integral temperature sensor that causes the valve to expand or contract allowing more or less heated water though the valve.

Circulatory systems incorporating modulating valves circulate warm water through both a water heater (of any type) and a modulating valve that is set to the desired delivery temperature. This is shown in Figure 4.19 using continuous flow water heaters, incorporating UV filtration and an isolating valve with a temperature sensor.

Isolation valves with temperature sensors can also be used to shut off the heated water supply should the temperature reach an unsafe level. UV sterilisation can also be included to maintain disinfection of the warm water systems; this is discussed in more detail in Section 8.

Figure 4.18 Typical example of a circulating warm water system where temperature is controlled by sensors within the continuous flow water heaters

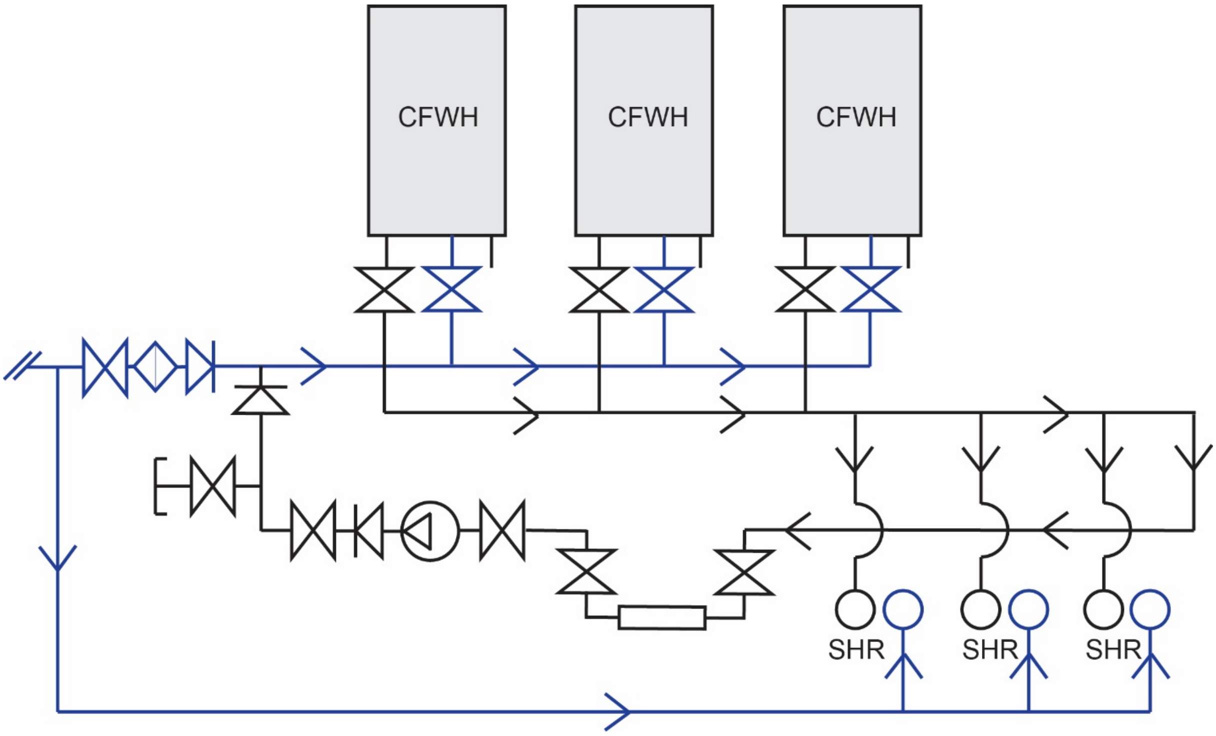
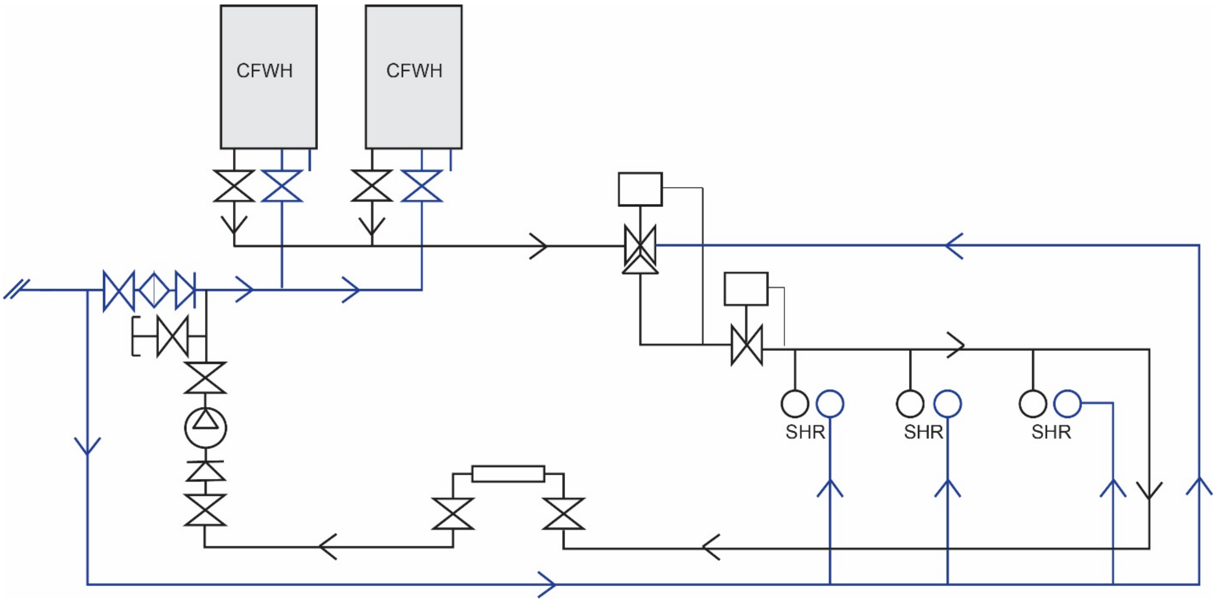


Figure 4.19 Typical example of a circulating warm water system regulating water temperature through a modulation valve



5 Installation

This section discusses some of the main components and areas specific to warm water systems, such as:

- pipework
- heating plant
- TMVs
- circulation and pumping
- temperatures.

5.1 Pipework

Careful consideration should be given to the layout of pipework. Building design, service access and ducts, heating plant location, etc., will always affect pipework installation for any system. When designing and installing pipework systems, avoiding thermal loss is critical as the efficient operation of a warm water system can be severely compromised if it is poorly managed. Excessive ‘dead water’ draw-off, i.e. where it is necessary to drain cooled water from the supply pipe prior to delivery of heated water, can result in unnecessary water and energy wastage.

5.1.1 Material

The use of certain chemicals in disinfection processes can increase the deterioration rate of pipework and fittings, and whole life system performance should be considered when selecting materials.

5.1.2 Insulation

Where pipework is not insulated there may be limited heat loss along the length of the branch when in use. However, insulation of the pipework branch lines will extend the time it takes the heated water to reduce to ambient temperature. The amount of insulation a product offers is measured by its R-Value. A component’s R-Value is its thermal resistance, calculated by dividing its thickness by its thermal conductivity.

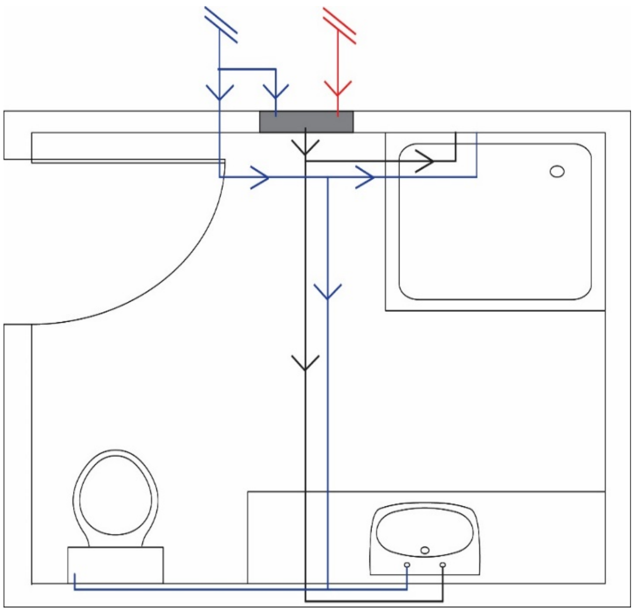
5.1.3 Dead legs in branch lines

Where an infrequently used fixture is located at the end of a branch line, water can cool around that fixture, heightening the risk of bacterial growth. This can create what is known as a ‘dead leg’. Both the pipe diameter and length are contributing factors in the amount of water contained in a dead leg.

An understanding of the risks associated with dead legs will assist in ensuring they are suitably addressed. These risks can be reduced by having the most frequently used fixture the furthest from the mixing valve and branches from the main line to other fixtures kept as short as possible. An example is shown at Figure 5.1.

Branch lengths from the warm water system should be kept to a minimum to limit the distance of pipework to infrequently used taps and fixtures. A branch length containing less than 2 litres or one that is less than 10 lineal metres is generally acceptable. Another way to measure it is to limit the time taken for heated water to reach the outlet to no more than 30 seconds.

Figure 5.1 Typical bathroom pipework layout



5.1.4 Estimating time delay

The following calculation methods can be used to determine the time it takes for heated water to reach the outlet and the quantity of water that is discarded. It is important to remember that the nominal size of pipework may not match the dimensions of the pipe. When undertaking calculations, internal dimensions of pipes should be sourced from the manufacturer.

To calculate the time delay, 3 steps are used:

1. Determine the capacity of fluid for the pipework.
2. Convert to litres.
3. Determine the time delay.

Step 1 Capacity of fluid

To calculate the capacity of fluid, Equation 1 can be used.

Equation 1 Capacity of fluid

$$C = \frac{\pi}{4} \times {d_\mathrm{i}}^2 \times l \div 1000$$

Where:

C	=	capacity of fluid (mL)
d_i	=	internal diameter (mm)
l	=	length (mm)

Example: Pipework capacity

For a 5 metre branch of 25 mm internal diameter (d_i) pipe, the capacity of fluid is calculated using Equation 1.

C = (3.14/4) x 25^2 x 5000 / 1000

= 0.78 x 625 x 5000 / 1000

= 2437.5 mL

Step 2 Convert the capacity from millilitres to litres

To convert millilitres (mL) to litres (L), Equation 2 can be used.

Equation 2 Millilitres to litres conversion

$$Litres = \frac{mL}{1000}$$

Example: Millilitres to litres

For the example above, use Equation 2 to convert 2437.5 mL to L.

L = 2437.5 / 1000

= 2.44 L

Step 3 Estimation of time delay

Once the amount of water wasted has been established, the time delay can be estimated through Equation 3.

Equation 3: Estimation of time delay

$$t = \frac{C}{F}$$

Where:

t	=	time delay - amount of time for heated water to reach the outlet (min)
C	=	Capacity (L)
F	=	Flowrate of outlet (L/min)

Example: Time delay

For a branch of 25 mm d_i pipe with a length of 5 metres and an outlet flowrate of 9 L/min, the time delay is calculated using Equation 3.

t = 2.44 / 9

= 0.27 minutes.

5.2 Heating plant

This Handbook does not go into detail regarding water heating plant, as there is limited detail specific to warm water systems. However, there are many different types of heated water plant available for warm water systems. The major technology types include:

- gas continuous flow (instantaneous)
- gas storage
- large gas water heaters
- electric storage
- heat pump
- solar
- combinations of the above.

The selection is determined by a number of factors including the:

- type and layout of the building
- usage pattern
- source of energy
- location of the plant
- initial plant cost and the ongoing operational costs
- TMV requirements, where used
- circulation
- temperature needs.

All warm water heating plant and associated equipment should comply with the relevant manufacturer's installation instructions.

5.3 Thermostatic mixing valves (TMVs)

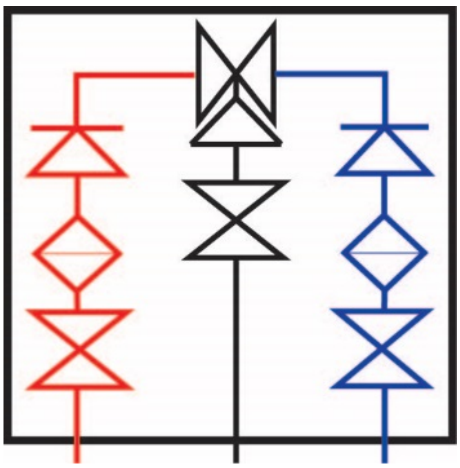
Thermostatic mixing valves (TMVs) are devices that ensure the delivery of heated water at a specified temperature to an outlet by mixing the heated and cold water supplies. TMVs are not the only means of limiting the temperature. However they are one of the most common.

5.3.1 Operation

The temperature of water in a TMV is regulated within the valve by an actuating device that expands and contracts to the mixed water temperature to adjust the flow of heated water. When installing TMVs, the distance from the TMV to the outlet being served should be considered and the valve calibrated to account for any temperature loss.

The function of a TMV ensures the delivery of heated water at a specified temperature. A TMV usually contains non-return valves, line strainers and a means of isolation of both cold and heated water inlets as an integral part of the device (see Figure 5.2). This provides a means of testing the thermal shutdown of the device. Thermal shutdown occurs if there is a loss of cold water supply but the heated water is still available. The valve will shut off the supply until the cold water supply is reinstated. For this reason, TMVs are commonly used in hospitals, schools and aged care facilities, with a requirement for annual testing. This reduces the risk of scalding by enabling the TMV to be monitored to ensure correct operation. The testing and maintenance of TMVs is discussed in section 5.3.3.

Figure 5.2 Integral components of a TMV



5.3.2 Installation

When installing a TMV, it is important to consider the pressure drop created by the device and that the pressure differential between the heated and cold water supply is limited to within 10% for both static (not in operation) and dynamic (in operation) pressures. Tapware with thermostatic mixing incorporated is available as a point of use tempering option. A minimum pipe length of 1 metre is recommended from the TMV to the first outlet to reduce the effect of a possible heat spike and help minimise any temperature increase should the failsafe function of the TMV be initiated. The length of pipe installed will assist in dissipating the heated water.

A pipe branch should contain no more than 2 L of water or exceed 10 lineal metres from the flow and return line of a circulatory system or the TCD of a reticulated system to the fixture outlet. This will ensure heat loss and microbial growth is minimised, unless a heat trace system is used to maintain system temperature. A pipe material's heat loss properties, the volume of water and valve specifications should also be considered when determining branch lengths.

It is important to correctly size TMVs. Larger sized mixing valves should only be used where there is low inlet pressures or large draw offs at the outlet.

When one TMV is serving multiple fixtures across separate bathrooms, simultaneous fixture use can cause some imbalance and variation in the temperature and heated water pressure being supplied. The TMV must be able to tolerate pressure variations caused by simultaneous fixture use without warm water departing from the allowable temperature range. This must be considered at the design stage and assessed during commissioning.

5.3.2.1 Installation considerations

The operating pressure of both heated and cold water supplies at the inlet to a TMV needs to be nominally equal to or within 10% imbalance. This will prevent any variations in temperature at the outlets. Pressure variance may be more prevalent where one TMV is servicing a number of outlets. Pressure reducing or limiting valves may be necessary to achieve nominally equal inlet pressures.

TMVs should not be installed in parallel on the same line unless the valve is approved for such installations as this could affect the temperature control and thermal shut-off operations of the TMV.

Generally, TMVs require a minimum temperature differential of 10°C between the heated and cold water to operate effectively.

5.3.2.2 Heated water usage

To assess the amount of heated water used by a TMV, Equation 4 can be used. This calculation will assist in determining the storage requirements for heated water services. For example: with temperatures of 20°C cold, 45°C tempered and 70°C heated, the percentage proportions are 50/50 between cold and heated.

Using the example shown in Equation 4, where the TMV is serving two showers each with a flow at the outlet of 9 L/min, the temperatures recorded are:

- cold = 20°C
- tempered = 45°C
- heated = 80°C.

Equation 4: Heated water usage

$$HV\% = 100 \times (M - C) \div (H - C)$$

Where:

HV%	=	percentage of heated water used
M	=	temperature of tempered water (°C)
H	=	temperature of heated water (°C)
C	=	temperature of cold water (°C)

Example: Determining heated water usage (%)

Using the temperatures above, the split percentages of flow use is calculated using Equation 4:

HV% = 100 x (tempered – cold) ÷ (heated – cold)

= 100 x (45 – 20) ÷ (70 – 20)

= 50%

This means that 42% of the water being supplied to the outlet is from the heated water supply.

To convert from litres per minute to litres per second, Equation 5 can be used.

Equation 5 Conversion of litres per minute to litres per second.

$$\mathrm{L/s} = \frac{\mathrm{L/min}}{60}$$

Example: Conversion of L/min to L/s

18 Litres per minute converted to litres per second.

L/s = 18 (L/min) ÷ 60

= 0.3 L/s

To convert litres per second to litres per minute Equation 6 can be used.

Equation 6 Conversion of litres per second to litres per minute

$$L/\mathrm{min} = L/\mathrm{s} \times 60$$

Example: Conversion of L/s to L/min

0.3 litres per second converted to litres per minute.

L/s = 0.3 (L/s) x 60

= 18 L/min

5.3.3 TMV testing and maintenance

All TMVs should be inspected, tested and serviced to ensure adequate operation. In some cases, risk assessment may establish a requirement for more frequent testing and maintenance. In some jurisdictions such as the Australian Capital Territory, New South Wales, Northern Territory and Queensland, TMV maintenance is required to be undertaken by an appropriately licenced plumber; this should be assessed prior to undertaking any testing.

AS 4032.3:2004 states that in the absence of a risk assessment, field testing shall be carried out at intervals of no more than 12 months for TMVs.

5.3.3.1 Testing requirements

The minimum activity during testing includes the following:

- strainer cleanliness
- non-return valve operation
- discharge temperature measured at the nearest outlet to the valve for high and low flow
- cold water shut-off operation (thermal shut off)
- hot water shut-off operation (cold shock test)
- isolation valve test
- replacement and lubrication of dynamic ‘o’ rings and seals at intervals not exceeding 5 years from commissioning or shorter intervals indicated by the manufacturer.
- The following is reported:
    - the model, manufacturer and identification of the valve
    - location of the valve
    - temperatures recorded during test
    - details of tests, maintenance and parts replaced
    - reference to the test method.

State and Territory requirements for testing are included in Table 1. References to Standards in this table are those of the source documents.

Table 1 State and Territory TCD testing requirements

State / Territory	Testing requirements
ACT	No information found
NSW	The Public Health Act, the Public Health Regulation 2000 and the NSW Code of Practice for Thermostatic Mixing Valves in Health Care Facilities, AS 4032.3 as well as any manufacturer’s published instructions shall be followed in regard to the system design, installation, commissioning, operation, maintenance / service and site management of all warm water and hot water supply systems.

State / Territory	Testing requirements
NT	No information found
Qld	No information found
SA	Temperature controlling devices such as TMVs or TVs should be regularly serviced in accordance with the manufacturer's instructions and AS 4032 and, in any case, at least every 12 months.
Tas.	The owner of a warm water system that uses thermostatic mixing devices must ensure that the warm water system is maintained in accordance with the requirements of AS/NZS 4032:1998.
Vic.	It is a requirement of AS/NZS 3500.4 that TMVs "be inspected periodically to ensure proper operation". The Victorian Building Authority recommends that TMVs are inspected and serviced annually in accordance with AS 4032.3.
WA	TCDs require routine maintenance and performance testing. Information on maintenance can be found in AS 4032.2.

5.3.3.2 Testing procedures for TMVs

The following procedures apply to the testing of TMVs to ensure they are functioning accurately:

- thermal shut off test
- cold shock test.

Thermal shut off test

The following should be measured and recorded during this test:

- thermal shut-off reaction time
- the maximum temperature of the discharge water during this period.

Steps:

1. Close the isolating valve in the cold water supply line to the TMV quickly, to completely stop or isolate the flow of cold water. This action should cause the TMV to rapidly respond and provide a quick, thermal shut off operation.

2. Measure the time elapsed between the complete shut-off of the cold water isolation valve to the cessation in flow of water discharged from the warm water outlet. The thermal shut off time should not exceed 4 seconds.
3. Keep the cold water supply line isolating valve shut.
4. Any water subsequently produced by the TMV should not exceed the maximum permissible temperature limit.
5. For a period of 30 minutes, the temperature of the discharge water should be kept under constant visual observation.
6. At intervals of 5 minutes, the temperature of any water still being emitted from the outlet should be recorded during this period.
7. The maximum accumulated flow of any leakage water should not exceed 20 L.

   Open the cold water supply isolation valve quickly then measure and record the time taken for the TMV to be reactivated and produce stable warm water at the outlet.

   - The elapsed time should not exceed 10 seconds and the discharge water temperature should not exceed the maximum permissible temperature limit.
   - Warm water produced at the outlet should be between
     - 38°C and 40.5°C for children; and
     - 40.5°C and 45°C for adults.

Cold shock test

The following should be measured and recorded during this test:

- reaction time
- accumulated flow of water emitted from the mixing valve during the reaction time or thirty seconds, whichever is the lesser time.

Steps:

1. Close the isolation valve in the hot water supply line to the TMV quickly to completely stop or isolate the flow of heated water.
2. Measure the reaction time from the time of complete shut-off of hot water to the complete cessation of output or a significant reduction of output of water discharged from the warm water outlet.
3. This action should cause the TMV to rapidly respond and provide either a complete cessation of output or a significant reduction of output within a reaction time of 4 seconds.

5.4 Circulation

Circulatory systems are commonly used in the design of warm 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 cooler water to the heating plant using a pump or pump set, usually installed on the cooler return line.

A backflow prevention device such as a check valve can also be used to prevent backflow through pumps, strainers and flow meters when not in operation. This will also protect from the mechanical forces associated with surge pressures as the pump stops. Pumping equipment should contain a means of disconnection to enable pump maintenance.

Correct pump selection is critical as they must have sufficient design pressure and flow rate for the system. Incorrect pump selection can cause excessive energy consumption and an undersized pump may result in heating plant operating at a much higher and fluctuating temperature, whereas an oversized pump may result in excessive water velocities, should the system not incorporate balancing valves. Stand-by pumps and hammer arrestors need to be avoided as they may create dead legs and increase the risk of microbial growth.

Practitioners also need to consider the potential for erosion of heated water piping systems. One cause is through excessive velocities of heated water, where air bubbles and/or suspended solids through turbulent areas of pipework, such as bends, can erode pipework prematurely and cause excessive pipework noise within a building.

Pipe sizing and heat loss should also be taken into consideration as they may influence the required pump duty and pipe velocities. For example, the calculation of pump duties is not only dependent on the previously mentioned elements but also the contained volume of the pipe (pipe size) and the heat loss per metre (pipe length and insulation). This would allow for the heat loss to be balanced with the required flow rate of the pumps, which should affect the required pipe sizes to achieve acceptable velocities and friction loss within the system.

It is common practice to install a set of multiple pumps rather than a single large pump. Pumps can then be set to a schedule and in the event of a failure, an alarm can be raised and the other pump used.

Generally, a circulating pump is selected based on the following criteria:

- static pressure available at the cold water main connection
- length of service loop pipe
- size of service loop pipe (all pipe sizing)
- friction loss in the loop piping
- water velocity
- pipe length and insulation
- pump head loss through the system
- appropriate corrosion resistant materials
- temperature of the water intended to be circulated.

Circulation of heated water can be continuous or pumps can be regulated by:

- pre-programed timers
- pump elevation
- manual operation such as initiation buttons
- motion sensors
- thermostatic controls.

5.4.1 Installation considerations

The minimum flow rate for most continuous flow gas water heaters is between 2 to 3 L/minute. If water circulates through the system at a lower flow rate, it is possible that the booster will not ignite. Minimum system requirements identified by the manufacturer should be adhered to.

5.4.2 Temperature and Legionella risks

There are two main risks associated with water temperature, bacteria growth and scalding. Heated water stored at temperatures too low can promote the growth of disease-causing bacteria and temperatures delivered too high can increase the risk of scalding.

5.4.2.1 Scalding

Scalding or epidermal necrosis from heated water is a risk for all users should a warm water system fail or be incorrectly installed. However, this risk is far greater for people who are more vulnerable, such as people with disability, the elderly, children and infants, who may have a reduced reaction time and thinner skin. The higher the water temperature, the shorter the exposure time necessary to cause serious scalding. Research has found that at a temperature of 54°C children can burn in about one quarter the time of an adult.

5.4.2.2 Outlet temperature classifications

The temperatures given in Table 2 can be used to provide guidance for the classification of cold, warm and heated water temperatures and associated coding for tapware. These colours are used to identify the water temperature at the outlet of a fixture. This can be achieved through the indicator lettering on the tapware or the colour of the tap handle.

Table 2 Water temperature indicator guide

Tap outlet	Water Temperature	Tap Indicator or handle colour
Cold	Not heated	C - Blue
Warm	38°C – 45°C	W - Yellow
Heated	> 45°C	H - Red

6 Legionella pneumophila

Waterborne legionellosis is an illness caused by Legionella pneumophila and other Legionella species. The severity of Legionellosis varies from mild febrile illness (Pontiac fever) to a potentially fatal form of pneumonia (Legionnaires' disease). These Legionella-associated illnesses can affect anyone, but age, illness, immunosuppression or other risk factors, such as smoking, greatly increase susceptibility.

Legionella pneumophila is a common waterborne organism that grows in temperatures between 20°C and 45°C, with optimum growth at 32–42°C (see Table 3). The doses of Legionella pneumophila bacteria required to cause infection is unknown.

Table 3 Temperature effects on Legionella bacteria

Temperature	Effect on Legionella bacteria
70°C	Destroyed almost instantly
60°C	Reduction time of 2 minutes
50°C	Reduction time of 80 - 124 minutes
32°C - 42°C	Greatest reproduction rate
20°C - 32°C	Increase of reproduction rate
20°C and under	Dormant

Note: The table above refers to decimal reduction time and is the time required at a given condition (e.g. temperature), or set of conditions, to destroy or reduce the exposed microorganisms.

Legionnaires' disease is caused when Legionella pneumophila is present within airborne droplets of water and inhaled by a susceptible person, leading to an infection of the lungs. To assist in removing potentially contaminated airborne droplets, in addition to other control methods, adequate mechanical exhausting of shower areas should be provided to extract any airborne moisture which may be contaminated with bacteria.

The NCC Volume Three – the PCA, sets out the requirements for:

- microbial control in mechanical heating, cooling and ventilation systems in Part E1; and
- Legionella control in Part B2.

7 Maintenance

Because of the inherent risks associated with warm water, Legionella specifically, all systems need to be suitably designed, installed, commissioned and carefully monitored. An on-going monitoring system and water quality maintenance regime needs to be introduced. The aim of these steps is to avoid conditions that may allow bacteria such as Legionella to multiply.

Maintenance routines may differ from site to site depending on installation. However, it is important to have processes in place such as:

- regular inspections, monitoring and recording of:
  - pressure of cold water
  - flow rate of cold water
  - pressure of warm water
  - temperature of warm water
  - flow rate of warm water
  - temperature of cold water where the flow rate of cold water is to be calculated rather than measured
  - the time taken for the warm water to reach the prescribed operating temperature in degrees Celsius (°C)
- water sampling and testing
- chlorination and/or thermal disinfection
- UV operation;
- valve servicing, including:
  - testing of non-return valves
  - cleaning of line strainers
  - testing of TCDs
  - testing of thermal shut-off
- flushing of the dead legs on fixtures that are infrequently used; and
- review of maintenance procedures and risk assessments.

The maintenance and disinfection of warm water systems are legal requirements in some jurisdictions.

When maintenance of a warm water system is being carried out, contamination of adjoining areas and the ambient environment by aerosols, dust, particulate matter or effluent must be minimised and public access to the area in which the maintenance is being carried out prevented.

Details of any repairs, modifications, replacement parts or any other work carried out on the warm water system should be detailed in a maintenance service report and it is recommended that the site manager or building owner be made aware of any work conducted.

7.1 Risk management

A risk management approach to Legionella, such as that undertaken in Victoria, requires that reasonable steps be taken to manage the risks of Legionella. Risk assessments should be undertaken by suitably competent persons and risk management plans are developed as part of this process. In assessing the risks associated with warm water systems, it is important to undertake the following:

- determine the potential for susceptible people to be exposed to respirable sized droplets
- identify dead legs including those created by unused or infrequently used outlets
- develop a water sampling strategy and commence regular sampling for bacteria, specifically Legionella
- develop a clear procedure should the presence of Legionella bacteria be detected
- undertake a site audit to locate, gather and document basic information about each warm water system.

The risk assessment should determine whether existing control measures are sufficient and operate effectively. If they are not sufficient, additional measures should be identified and introduced.

In higher risk facilities, such as hospitals and residential aged care facilities, water from the outlet should be free of Legionella (no colonies detectable in 1 L of water). In Queensland, every Queensland Health hospital and Queensland Health operated residential aged care facility, and all private health facilities must have a water risk management plan (WRMP).

A WRMP is an active strategy to ensure the protection of public health from water-related hazards, such as water-borne bacteria and chemicals, while maintaining the quality, safety and reliability of water throughout the facility. For more information see the [Queensland Health, Create a water risk management plan website] (health.qld.gov.au).

Outbreaks of Legionellosis generally cause a higher rate of mortality in the people exposed. Therefore, immediate action is required if there is suspicion of an outbreak. If Legionella is detected in a water sample, the facility should immediately investigate whether the control measures are adequate, and then system control measures should be assessed and checked to identify whether any failures have occurred. If any failures are identified, remedial action should always follow. The relevant local public health authority should be contacted promptly for advice on an appropriate response to a suspected case of Legionnaires' disease, to ensure that the response is proportionate to the risk, can be undertaken appropriately and meets any regulatory requirements. Legionnaires' disease is notifiable in all the states and territories of Australia and in New Zealand.

More information can be found in the following document produced by enHealth (the Environmental Health Standing Committee):

> Guidelines for Legionella control in the operation and maintenance of water distribution systems in health and aged care facilities 2016.

8 Water sampling for microbiological analysis

Water sampling should only be undertaken by appropriately qualified personnel and can be used to determine:

- the quality of water provided from network utility operator
- effect of the plumbing system within the building on water quality
- effect of the tapware on water quality.

Important issues to consider when water sampling include:

- sampling points
- sampling techniques
- transport and storage.

Further guidance on areas of water quality sampling for microbiological analysis should be requested from the relevant Health Department.

8.1 Flushing, disinfection and decontamination

Risks associated with Legionella growth in warm water systems can be managed in a number of ways such as flushing, disinfection and decontamination.

8.1.1 Flushing

Routine flushing of fittings and branches is recommended, especially for fixtures and appliances with minimum use, because stagnant water supports the growth of Legionella.

Any outlet that has not been used for more than 7 days should be flushed at full flow until the operating temperature of the system has been reached.

8.1.2 Disinfection

Disinfection is an ongoing process that reduces known or suspected microbial contaminants to negligible or low concentrations. Preventative maintenance such as system disinfection is essential for the minimisation of the risk of Legionella bacterial growth in warm water systems. This can be done continuously or periodically at monthly to 6 monthly intervals and achieved through:

- heat disinfection (pasteurisation or thermal shock disinfection)
- chlorination (continuous or as a shock dose)
- chlorine dioxide
- copper-silver ionisation
- UV disinfection
- ozonation
- point-of-use microfiltration.

Table 4 provides an overview of disinfection systems and their strengths and weaknesses.

Table 4 Overview of systematic and localised disinfection treatments

Technology	Description	Strengths	Weaknesses
Heat disinfection	Periodic heating of the calorifier or water heater to a temperature sufficient to achieve 70°C at all outlets and then flushing heated water through all heated ring mains, heated water pipework and heated water outlets to control Legionella	• Relatively simple (theoretically but generally not in practice) • Does not require addition of chemicals	• Scalding hazards from the super-heated water • Requires considerable hours of labour • Results in a high volume of wastewater • Uses a large amount of energy to heat water • Many facilities do not have sufficient hot water capacity to offer this method • Has poor long-term control • May unintentionally lead to significant heat transfer to cold water • Cannot be used to disinfect cold water pipework
Chlorination	Sodium hypochlorite, chlorine dioxide, chlorine gas or chloramines added to the water to control Legionella *Note: Use of chloramines requires the addition of chlorine and ammonia in controlled doses and ratios with effective mixing and good pH control* *Suitable for systemic but generally not for localised treatment*	• Relatively easy to implement and monitor • Relatively cost effective depending on dosing equipment required and volume of chlorine needed • Easily installed in existing systems, without major modifications • Residual effect for downstream decontamination	• Potential corrosion of pipework and other plumbing infrastructure • pH must be maintained at ≤7.6 to be effective, (excluding chloramines) • Free residual chlorine and chloramines decay rapidly at hot water temperatures (≥60°C) • Different concentrations are required for residual disinfection and superchlorination (refer to 8.1.3.2) • Generation of undesirable disinfection by-products such as trihalomethanes • May be incompatible with reverse osmosis membranes (if used) • Removed by activated carbon filtration and UV light (if used)

Technology	Description	Strengths	Weaknesses
Copper–silver ionisation	Copper and silver ions released into the water to control Legionella	• Does not corrode piping or plumbing fixtures • Remains effective at all water temperatures • Easily installed in existing systems without major modifications • Residual effect for downstream decontamination	• Difficult to optimise the correct dosing for each system if the unit is not installed appropriately • Water hardness and pH can affect the efficiency of the system • Monitoring levels of silver and copper in the system is difficult • Not commonly used in Australia or New Zealand, therefore minimal local experience is available
Ultraviolet (UV) light	UV light with a wavelength of 250–265 nanometres controls Legionella	• Useful for small areas that may need additional or special attention, such as a high-risk unit • Relatively easy to install • No adverse effect on water or plumbing • Leaves no taste or chemicals in the water • Has no disinfection by-products	• Limited application (point-of-use or supplementary disinfection tool) • Affected by turbidity and particulates, which ‘shade‘ bacteria from the UV, rendering it less effective • No residual effect • Performance depends on the system being designed to be suitable for the flows • No effect on biofilm • Lamps need to be replaced on a regular basis
Ozonation	Gas generated on site and added immediately to water to control Legionella	• Effective over a wide pH and temperature range compared with chlorine • Very strong oxidiser • Effective at low concentration	• No residual effects • High concentrations may damage piping, fittings and seals • Minimal impact on biofilm-bound Legionella • Unstable, so must be produced on site and used immediately • Can produce harmful by-products in drinking water

Technology	Description	Strengths	Weaknesses
Point-of-use microfiltration	Membrane filter installed at or near outlet with pore size of ≤0.2 μm, which prevents most bacteria from passing through while allowing normal water flow	• May assist where other methods are unable to control Legionella or in areas where disinfectant residuals are to be avoided (e.g. dialysis) • Can be a useful supplement to another form of disinfection for high-risk areas • Has no disinfectant by-products	• Must be periodically replaced • Relatively high maintenance burden • Plumbing modifications may be required

Other equipment that is recommended to monitor and control disinfection includes:

- compact Oxidation-Reduction Potential (ORP) controllers and industrial ORP probes
- diaphragm metering pumps (up to 1600 kPa)
- frequent maintenance regimes for the calibration of pumps and probes and refill of chemical disinfectant supplies.

ORP probes and sensors are useful as they measure the rate of oxidative disinfection caused by the addition of the effects of all oxidants in the water. The unit of measurement of ORP is millivolts (mV). The more contaminants or oxidisers there are in the water, the less dissolved oxygen. This is because the contaminants are consuming the oxygen and lowering the ORP level or millivolt value. The higher the ORP level or mV level, the more ability the water has to destroy contaminants such as microbes or carbon-based contaminants.

More information can be found in the enHealth guidelines for Legionella control in the operation and maintenance of water distribution systems in health and aged care facilities (2016). More information on ORP can be found in the NSW Government's ORP Fact Sheet.

8.1.3 Decontamination

Decontamination is the response to a loss of control signalled by detection of Legionella or the preventive maintenance action of applying a treatment to a system, in conjunction with system cleaning, in order to reduce the general concentration of bacteria. Based on State and Territory health authority publications, the two most common methods of system decontamination recommended are:

- pasteurisation (heat)
- chlorination.

Both methods of decontamination should only be carried out by suitably qualified persons.

8.1.3.1 Pasteurisation (heat)

Firstly, ensuring that there is no scalding risk to occupants, warm water services should then be heated to a minimum of 70°C for a period of not less than one hour as a means of system decontamination. This can be done by increasing the temperature of the system then flushing at full flow for a minimum of 5 minutes at each individual fixture or simultaneously flushing fixtures connected to the branch. Some models of TMVs incorporate a manually controlled, hot water bypass to aid in the pasteurisation process. Temperature should be confirmed by digital thermometer and recorded. This process may be undertaken as frequently as monthly. Pasteurisation may not be practical for all warm water outlets in a simultaneous manner and a systematic and progressive procedure may be necessary. Consideration should be given to system and health and safety issues associated with undertaking pasteurisation disinfection.

In some large installations with extended circulation loops, it may take longer than 1 hour to perform a full circulation. The time duration should commence once the return temperature directly upstream of the hot water plant reaches >70°C.

Monitoring of temperature is important to ensure that systems are working as designed and that development of conditions that will strongly support Legionella growth has not occurred, e.g. water temperatures closer to 37°C. Lower than expected temperatures will also indicate low flows/stagnant water, which will promote Legionella growth.

8.1.3.2 Chlorination

This decontamination method involves the use of high concentration levels of chlorine and consideration should be given to system materials and health and safety implications.

If the warm water system incorporates a heated or warm water storage system, drain any sludge that may have accumulated in the bottom. Ensure there is an adequate backflow prevention to prevent any contamination of the cold water supply. Add chlorine with a dosage of approximately 10 mg/L within the storage system and at least 7 mg/L measured at all outlets and a pH of between 7.0 and 7.6. Each outlet should be flushed at full flow for a minimum of 5 minutes. Systems that have been decontaminated by chlorination need to be adequately flushed before being put back into operation.

Legionella is sensitive to chlorine and the presence of residuals >0.5 mg/L will provide a high degree of assurance that Legionella will be absent in the free body of water and that disinfection of the system is functioning effectively.

The Australian Drinking Water Guidelines provide a number of fact sheets that provide information on the physical and chemical characteristics and guidelines on chemicals for chlorination disinfection.

The different methods and requirements for disinfection and decontamination in each State and Territory are identified in Table 5.

Table 5 Methods of disinfection

State / Territory	Methods of disinfection and decontamination
ACT	Warm water storage systems must be disinfected by one of the following methods: • Heat disinfection at 70°C flushing each outlet in turn for two minutes. • Chlorine disinfection with free chlorine residual of not less than 7 mg/L at one outlet, preferably the furthest point downstream.
NSW	Dose the warm water storage tank with sodium hypochlorite to maintain a free chlorine residual of 5 – 10 mg/L for at least 30 minutes.
NT	No information found
Qld	No information found
SA	Warm water systems must be completely flushed at least 6 monthly with water of not less than 70°C for 5 minutes (or an equivalent temperature/time combination) or be treated with chlorine to provide a minimum free chlorine residual of 1 mg/L at all outlets.
Tas.	Heat decontamination of 70°C for a period of one hour or chlorine decontamination of a free chlorine residual in waster of not less than 7 mg/L at the outlet at the furthest point from the warm water storage system.
Vic.	No information found
WA	Warm water services should be heated to at least 60°C once each month for a period of one hour. Minimum maintenance – heated and cold water systems: clean and disinfection of system at least annually.

8.2 Water testing and sampling

Water sampling of warm water systems for microbiological examination and chemical analysis (such as testing for chlorine residuals) should be undertaken during the following stages:

- initial commissioning of the system
- if any components are modified
  if the system has not been in operation for longer than one month
- six monthly intervals throughout the operation of the system
- in accordance with the facility's WRMP.

Whilst testing is required in some jurisdictions, preventative risk management is recommended to minimise the presence of Legionella. A sample of the water in a warm water system should be taken from various outlets throughout the building, especially those that may not be used frequently. If a water sample shows a result of 10 or more Legionella colony forming units per millilitre (cfu/mL), the system should be flushed, disinfected and an additional sample be taken from the same point approximately 3 days after the initial test to ensure system disinfection. Table 6 identifies the water sampling requirements in each State and Territory.

When Legionella is detected it is recommended that action be taken immediately and the operation and maintenance program for the system be reviewed.

Note: It is evident that most issues occur at commissioning or shortly thereafter. As such, testing should be more rigorous in the early stages after commissioning. Water sampling of a warm water system should be undertaken at start up and then every month for six months to demonstrate that the disinfection process adequately controls Legionella bacteria.

Table 6 Water sampling requirements

State / Territory	Water sampling requirements
ACT	Water sampling of a warm water storage system must be undertaken at start up and then every month for six months to demonstrate that the disinfection process controls Legionella bacteria. Sampling must also be undertaken if the process of disinfection is modified or

State / Territory	Water sampling requirements
	if an authorised officer directs that sampling is to be undertaken.
NSW	The frequency of monitoring should be determined by the record of the performance of the individual systems. Once efficient systems and procedures have been established, regular monitoring may be reduced to less frequent intervals.
NT	No information found
Qld	No information found
SA	The relevant authority must, at least once in every 12 months arrange for a National Association of Testing Authority (NATA) accredited laboratory to conduct microbiological testing, in accordance with AS/NZS 3896 of at least 2 samples of water taken from each warm water system, to determine the presence and number of cfu of Legionella in the water.
Tas	Every six months, and at such other times as directed by an authorised officer, a representative sample of water is taken from the warm water system and tested in an accredited laboratory for the presence of Legionella.
Vic	Regulations no longer require testing warm water systems periodically for Legionella; it is recommended that all 'high risk' facilities undertake a water sampling program as part of a risk management approach.
WA	Legionella testing is also useful as part of an investigation of an outbreak: • validation of effectiveness of control measures • verification of the effectiveness of decontamination.

In higher risk facilities, such as hospitals and residential aged care facilities, water should be free of Legionella bacteria (0 cfu detectable in 1 L of water) due to the higher susceptibility of some patients and residents to infection.

Actions recommended at various populations of total Legionella in water systems where a single sample has been taken are given in Table 7.

Table 7 Control strategies for the presence of Legionella

Test results [(cfu/mL) detected (Legionella)]	Indication and control strategy
Less than 10 EnHealth - results of 0 (see note 2)	• Effective maintenance practices • System under control • Maintain current monitoring and treatment program • Disinfect (as appropriate)
Up to 100 EnHealth - 1 to 100 (see note 2)	• Maintenance practices may not be satisfactory • Decontaminate • Monitor and perform follow up testing
100 to 1000 (See note 1)	• Potentially hazardous situation • Re-evaluate maintenance procedures and disinfection process • Review control strategy • Decontaminate • Re-test water and assess if further remedial action is necessary
Greater than 1000	• Serious situation • Shut down system • Immediate decontamination (halogen based biocide recommended) • Review control strategy • Re-test water and assess if further remedial action is necessary

Notes:

1. Heterotrophic (Total) Plate Counts in excess of 100 cfu/mL for warm water systems may indicate that maintenance practices are not satisfactory.

2. Most testing for Legionella in Australia is based on a detection limit of <10 per mL (per the Australian Standard method). The enHealth responses listed in Table 7 are based on this type of testing and hence there is a mismatch between the Code of Practice ‘Prevention and control of Legionnaires' disease, 2010 and NSW Code of Practice for ‘the Control of Legionnaires' Disease, 2004 and the recommendation to test 1 L volumes. Testing larger volumes may be recommended rather than the standard testing per mL in some circumstances for higher risk facilities. Contact your State or Territory regulator for further information.

3. AS 3896, Waters – Examination for Legionella spp. including Legionella pneumophila, sets out a method for isolating and estimating the number of Legionella pneumophila and a range of other Legionella spp. in water. This method is applicable to all water samples, including recreational, industrial, waste and natural waters. While this method is suitable for the testing of all waters, there is a separate method (AS 5132 Waters – Examination for Legionella spp. including Legionella pneumophila – Using concentration) that is designed specifically for concentration of water where a lower limit of detection is required due to public health concerns.

Although Table 7 specifies a select list of control strategies, the available options are not limited to those listed. A control strategy or corrective action ensures an immediate response to a failure in a control measure and is entirely site-specific and risk based, which is a legislated requirement in some States and Territories.

Key components of corrective actions should be documented in and conducted as per the WRMP, with considerations to the following: notification, immediate response, and follow-up monitoring. More information can be found on the Queensland Health, Implementing a water risk management plan website.

Where Legionella is detected, it is recommended that action be taken immediately and the operation and maintenance program for the system be reviewed.

It is a requirement that testing of water samples for Legionella bacteria be performed at a NATA registered laboratory in the Australian Capital Territory, Queensland, New South Wales, South Australia and Tasmania.

9 Documentation

All maintenance actions, inspection observations, operating and maintenance manuals should be stored on-site and include:

- as-installed drawings of equipment and systems
- commissioning and cleaning procedures
- operating and shut down procedures
- dates and details of equipment and nature of servicing
- all appliance, tapware, valve, component and fixture documentation
- results of all tests.

In some jurisdictions such as New South Wales, warm water system operation and maintenance inspection checklists are provided from the health department.

10 References

The following is a list of documents considered during the development of this report:

Australian Government (2018). National Water Quality Management Strategy – Australia Drinking Water Guidelines 6

A. R. Moritz and F. C. Henriques, J. (1947). Studies of thermal injury II. The relative importance of time and surface temperature in the causation of cutaneous burns.

ACT Health. (2005). Cooling Towers, Evaporative Condensers and Warm Water Storage Systems (Specialised Systems) Code of Practice. Australian Capital Territory Government.

Australian Building Codes Board. (2019). National Construction Code Series - Volume Three, the Plumbing Code of Australia.

Chadderton, D. V. (2007). Building Services Engineering. Taylor & Francis.

Commission for Occupational Safety and Health. (2010). Code of Practice Prevention and control of Legionnaires' disease. Government of Western Australia.

Coomes Consulting. (2008). Background Research Project - Consideration of hot water circulators for inclusion in the WELS Scheme. Australia: Department of the Environment, Water, Heritage and the Arts.

Daryl McGregor Pty Ltd. (2011). Policy & Procedures for the Disinfection of Portable Water Supply Assets. Lower Macquarie Water Utilities Alliance.

Department of Health and Human Services. (2012). Guidelines for the Control of Legionella in Regulated Systems. Government of Tasmania.

Directorate of Estate Engineering Policy (DEEP). (August 2012). Microbial Control in Air Handling and Water Systems of Defence Buildings (Vol. 4). Canberra, ACT, Australia: Department of Defence.

enHealth. (2016). Guidelines for Legionella control in the operation and maintenance of water distribution systems in health and aged care facilities. Canberra: Australian Government.

Feck, M. S. (1980, July Vol. 70, No 7). Preventing Tap Water Burns. Public Health Briefs, pp. 727 - 729.

Feldman, K. W. (1983, January 1). Paediatrics Vol. 71. "Help needed on hot water burns', pp. 145, 146.

Health.vic (2010). Public Health and Wellbeing Act 2008: News Bulletin - Information for aged care, health services, health service establishments, registered funded agencies, correctional services and commercial vehicle washes. Victorian Government.

HydroChem. (2013). Information release - Warm Water Systems.

International Copper Association Australia. (1st Edition April 2014). Hydraulic Services Design Guide.

Kenneth W Feldman, R. T. (1998; 4). Tap water scald burns in children. Injury Prevention, pp. 238-242.

Moss, K. J. (2002). Heating and Water Service Design in Buildings. E & FN SPON.

MPA Skills. (2012). CPCPWT4013A Commission and Maintain Heated Water Temperature Control Devices. MPA Skills.

NSW Health. (2004). NSW Code of Practice for the Control of Legionnaires' Disease. New South Wales Government.

NSW Health. (2014). Part A - Approval specification for operational testing of thermostatic mixing valves for use in non domestic buildings in New South Wales. New South Wales Government.

NSW Health. (2014). Part B - Approval specification for operational testing of warm water generating systems not incorporating thermostatic mixing valves for use in non domestic buildings in New South Wales. New South Wales Government.

NSW Health. (Feb 2015). Policy Directive. Water - Requirements for the provision of cold and heated water. NSW Government.

NSW Health. (Jan 2005). Policy Directive: Water - Requirements for the Provision of Cold and Heated Water. NSW Government.

NT Health. (2014). Public Health Fact Sheet No. 407 - Legionnaires' Disease. New South Wales Government.

Plumbers Licensing Board. (2010). Technical Note - Water temperature.

Plumbing Industry Commission. (2004). HB 263 Heated Water Systems. Standards Australia.

Queensland Health. (2013). Legionnaires disease - reducing risk in the home. Queensland Government.

Queensland Health. (1999). Design Guidelines for Queensland Residential Aged Care Facilities. Queensland Government.

Queensland Health. (2013). Queensland Health Capital Infrastructure Requirements manual, Volume 1. Queensland Government.

Rheem Australia. (2012). Rheem Guardian Warm Water - Owners Guide and Installation Instructions. Rheem Australia.

Rinnai Australia. (2009). Demand Duo Warm Water Valve - Owners Guide and Installation Instructions. Rinnai Australia.

Rinnai Australia. (n.d.). Reference Guide - Commercial Hot Water. Australia: Rinnai Australia.

SA Health. (2013). Guidelines for the Control of Legionella. Government of South Australia.

SA Health. (2013). Public Health Fact Sheet #303 - Is my heated water system captured under the Legionella Regulations? Government of South Australia.

South Australia. (2013). South Australian Public Health (Legionella) Regulations.

Standards Australia. (2008). AS/NZS 3896 Waters - Examination for Legionella spp. including Legionella pneumophila. SAI Global.

Standards Australia. (2004). AS 4032 Water supply - Valves for the control of heated water supply temperatures Part 3: Requirements for field-testing, maintenance or replacement of thermostatic mixing valves, tempering valves and end-of-line temperature control devices. SAI Global.

Standards Australia. (2012). AS 2031 Water quality - Sampling for microbiological analysis (ISO 19458:2006, MOD). SAI Global.

Standards Australia. (2015). AS/NZS 3500 Plumbing and Drainage - Part 4: Heated Water Services. SAI Global.

Szabo, L. (n.d.). Fighting Legionella: Lessons from more than 100 hospitals and healthcare facilities. HydroChem.

Technical Advisory Centre for Health Facilities. (1990). Code of Practice for Thermostatic Mixing Valves in Health Care Facilities. The New South Wales Hospitals Planning Advisory Centre (HOSPLAN).

Thermon. (n.d.). Design Guide - Systems for hot water temperature maintenance.

Victorian Building Authority. (2014, June). Technical Solution Sheet 6.01. 6: Hot Water Plumbing - Achieving Hot Water Delivery Temperatures/Dead Ends. Victorian Government.

Victorian Building Authority. (2014, June). Technical Solution Sheet 6.03. 6: Hot Water Plumbing - Heat Trace Cables in Warm Water and Hot Water Systems. Victorian Government.

Victorian Building Authority. (2014). Technical Solution Sheet 6.11. 6: Hot water Plumbing - Warm Water Systems. Victorian Government.

World Health Organization. (2007). Legionella and the prevention of legionellosis.

APPENDICES

Appendix A Compliance with the NCC

A.1 Responsibilities for regulation of building and plumbing in Australia

Under the Australian Constitution, State and Territory governments are responsible for regulation of building, plumbing and development / planning in their respective State or Territory.

The NCC is an initiative of COAG and is produced and maintained by the ABCB on behalf of the Australian Government and each State and Territory government. The NCC provides a uniform set of technical provisions for the design and construction of buildings and other structures, and plumbing and drainage systems throughout Australia. It allows for variations in climate and geological or geographic conditions.

The NCC is given legal effect by building and plumbing regulatory legislation in each State and Territory. This legislation consists of an Act of Parliament and subordinate legislation (e.g. Plumbing Regulations) which empowers the regulation of certain aspects of plumbing and drainage systems, and contains the administrative provisions necessary to give effect to the legislation.

Each State's and Territory's legislation adopts the NCC subject to the variation or deletion of some of its provisions, or the addition of extra provisions. These variations, deletions and additions are generally signposted within the relevant section of the NCC, and located within appendices to the NCC. Notwithstanding this, any provision of the NCC may be overridden by, or subject to, State or Territory legislation. The NCC must therefore be read in conjunction with that legislation.

A.2 Demonstrating compliance with the NCC

Compliance with the NCC is achieved by complying with the Governing Requirements of the NCC and relevant Performance Requirements.

The Governing Requirements are a set of governing rules outlining how the NCC must be used and the process that must be followed.

The Performance Requirements prescribe the minimum necessary requirements for buildings, building elements, and plumbing and drainage systems. They must be met to demonstrate compliance with the NCC.

Three options are available to demonstrate compliance with the Performance Requirements:

- a Performance Solution,
- a DTS Solution, or
- a combination of a Performance Solution and a DTS Solution.

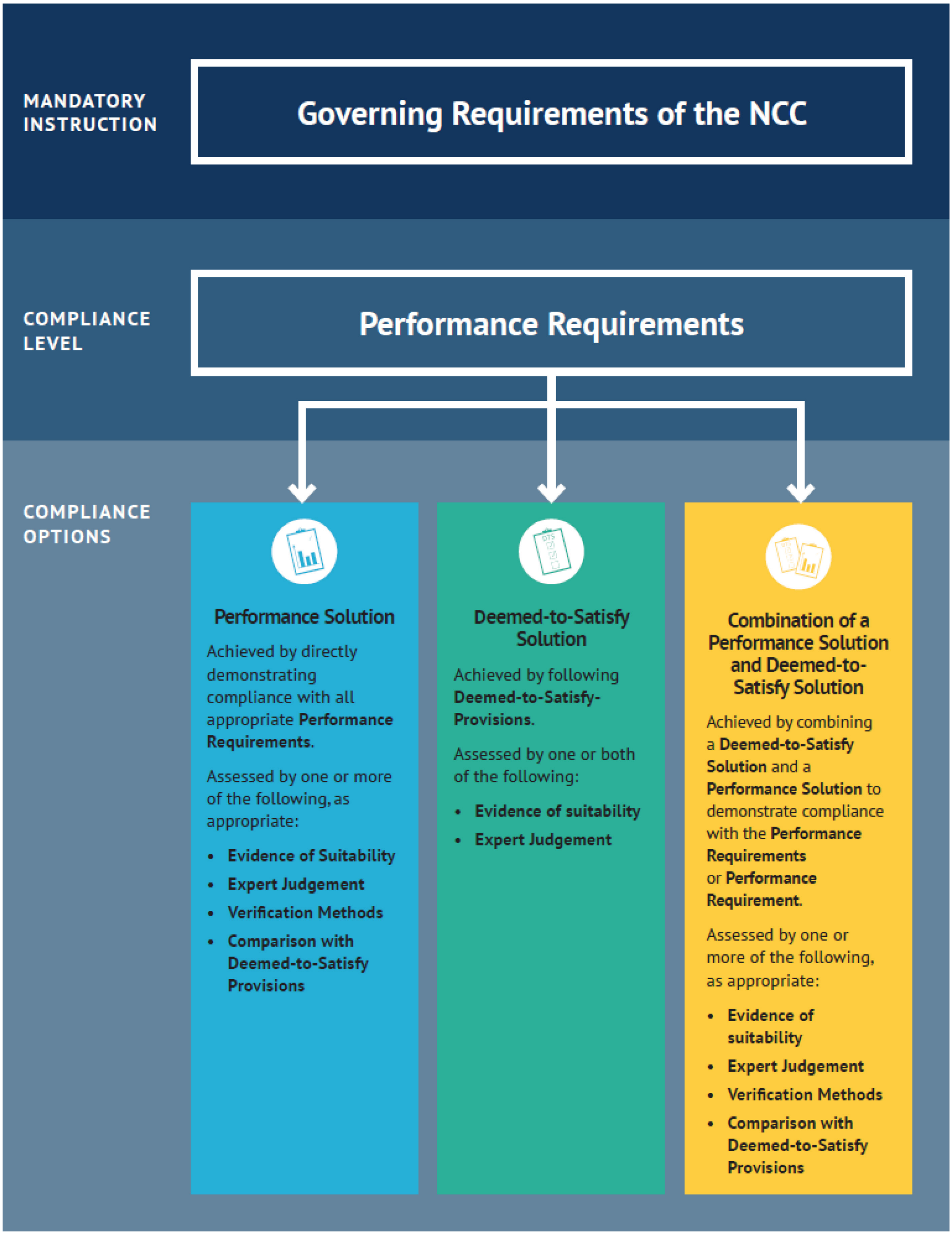
All compliance options must be assessed using one or a combination of the following Assessment Methods, as appropriate:

- Evidence of Suitability
- Expert Judgement
- Verification Methods
- Comparison with DTS Provisions.

The hierarchy of the NCC and its compliance options is shown in Figure A.1. It should be read in conjunction with the NCC.

To access the NCC or for further general information regarding demonstrating compliance with the NCC, visit the ABCB website (abcb.gov.au).

Figure A.1 Demonstrating compliance with the NCC

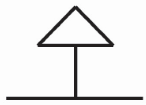
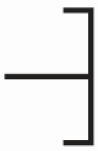
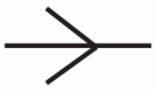


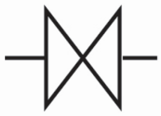
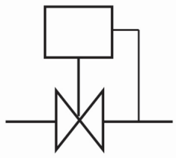
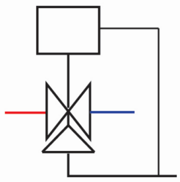
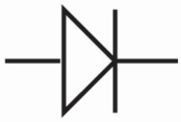
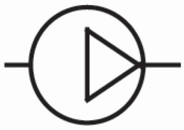
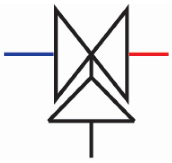
Appendix B Acronyms and symbols

Table B.1 contains acronyms and symbols used in this Handbook.

Table B.1 Acronyms and symbols

Acronym/Symbol	Meaning
°C	degrees Celsius
μg/L	micrograms per litre
ABCB	Australian Building Codes Board
AS	Australian Standard
ADWG	Australian Drinking Water Guidelines
BSN	basin
BCA	Building Code of Australia
Bth	bath
cfu	colony forming unit
cfu/mL	colony forming units per millilitre
CFWH	continuous flow water heater
COAG	Council of Australian Governments
d_i	internal diameter
kPa	kilopascal
L	litres
m	metres
m^2	square metre
mg	milligrams
mg/L	milligrams per litre
min	minute
mL	millilitre
mm	millimetre
mV	millivolt
NATA	National Association of Testing Authorities
NCC	National Construction Code
NZS	New Zealand Standard
ORP	oxidation-reduction potential
PCA	Plumbing Code of Australia

Acronym/Symbol	Meaning
pH	The term used to describe the hydrogen ion concentration in water, pH 7 is neutral
s	second
S	sink
SHR	shower
SWH	storage water heater
TCD	temperature control device
TMV	thermostatic mixing valve
Tr.(L)	laundry trough
TV	tempering valve
UV	ultraviolet
WH	water heater
WRMP	Water Risk Management Plan
	Air release valve
	Balancing Valve
	Cap
	Cold water pipe
	Direction of flow
	Fixture tap
	Heated water pipe

Acronym/Symbol	Meaning
	Isolation valve
	Isolation valve with temperature sensor
	Modulating valve with temperature sensor
	Non-return valve
	Pipe continuation
	Pump
	Temperature control device
	Tempered water pipe
	Ultraviolet filter

Appendix C Defined terms

C.1 NCC Defined terms

NCC definitions for the terms used in this Handbook can be found in;

- Schedule 3 of the NCC 2019.

Building classifications can be found in:

- Part A6 Building Classifications of the NCC

C.2 Other terms

For the purpose of this Handbook, the following definitions apply.

Chlorination – Sodium hypochlorite, chlorine gas or chloramines added to the water to control Legionella.

Continuous flow water heater (instantaneous) – An unvented water heater in which the heat energy is applied only while the water flows to an outlet.

Copper-silver ionisation – Copper and silver ions released into the water to control Legionella.

Dead leg – A length of water-filled pipe where there is little or no flow.

Dead water – The cold water drawn off before heated water commences to discharge from a heated water outlet.

Decimal reduction time – A unit of microbial heat resistance, defined as the time required to kill 90% of a population of microorganisms at a constant temperature, under specified conditions.

Decontamination – The reduction, to negligible or low concentrations, of a known or suspected contaminant, such as Legionella.

Dynamic pressure – The pressure in pipework under flow conditions.

Head – The total energy possessed by a unit weight of fluid due to its elevation, pressure and velocity. It is expressed as a height in metres of fluid.

Heat disinfection – (pasteurisation or thermal shock disinfection) Periodic heating of the calorifier or water heater to a temperature sufficient to achieve 70°C at all outlets and then flushing heated water through all heated ring mains, heated water pipework and heated water outlets to control Legionella.

Heated water reticulation – Other than the actual water heater, all parts of the installation and all equipment and materials necessary to provide a supply of heated water at the specified outlets.

Heated water service – All parts of the installation including the water heater and all equipment and materials necessary to provide a supply of heated water at the specified outlets.

Isolation valve – Any valve for the purpose of isolating part of a water system from the remainder.

Legionnaires' disease – The most severe and common form of pneumonia caused by Legionella pneumophila. Symptoms are nonspecific, however the disease has rapid onset and can be fatal.

Legionellosis – Generic term used to describe infections caused by Legionella pneumophila, which can range in severity from a mild, febrile illness (Pontiac Fever) to a rapid and potentially fatal pneumonia (Legionnaires' disease).

Mixing valve – A valve in which separate supplies of heated water and cold water are mixed together, either automatically or manually, to give a desired temperature from the mixed water outlet.

Non-return valve – A valve to prevent reverse flow from the downstream section of a pipe to the section of pipe upstream of the valve.

Oxidation-Reduction Potential (ORP) probe – A device used to measure very small voltages generated with a probe placed in ozonated water.

Ozonation – Gas generated on site and added immediately to water to control Legionella.

Point-of-use microfiltration – Membrane filter installed at or near outlet with pore size of ≤0.2 μm, which prevents most bacteria from passing through while allowing normal water flow.

Pressure limiting valve – A valve that limits the outlet pressure to a set pressure.

Primary flow and return circuit – Piping system that conveys heated water to and from the source of heat and the storage container.

Pump – A mechanical device used for raising fluids from a lower to a higher level or for circulating fluid in a pipework system.

Return pipe – A pipe in a primary flow and return circuit, in which heated water moves back to the heat source, or a pipe in a secondary flow and return circuit in which heated water moves back to the storage container.

Sanitary facility – A bathroom or the like containing multiple plumbing fixtures primarily used for personal hygiene.

Secondary flow and return circuit – A piping system that conveys heated water to and from a storage container and heated water draw off points.

Storage water heater – A water heater that incorporates a thermally insulated container in which the water is heated and stored for subsequent use.

Temperature control device (TCD) – Either a tempering valve (TV) or a thermostatic mixing valve (TMV).

Tempering valve (TV) – A mixing valve that is temperature actuated and is used to temper a heated water supply with cold water to provide heated water at a lower temperature.

Thermal shut off – A term used to describe the function of promptly and automatically either shutting off or significantly reducing the flow of water, should either:

(a) the cold water supply to the warm water generator be inadequate or be interrupted; or
(b) there is a malfunction of the product that is covered by the operation and maintenance manual for the product.

Thermostatic mixing valve (TMV) – A mixing valve by which the temperature of the water from the mixed water outlet is automatically controlled by a thermostatic element/sensor to a preselected temperature that is suitable for direct contact with the skin.

Ultraviolet (UV) light – UV light with a wavelength of 250–265 nanometres controls Legionella.

Warm water – Heated water within the temperature range of 38°C to 45°C as measured at an ablution outlet fixture.

Warm water generator – A water heating appliance that generates warm water by heating cold water and can control the output temperature.

Appendix D Acts, Regulations and design responsibilities

D.1 Other Applicable Acts, Regulations and design responsibilities

Each State and Territory, and Australian Government has differing legislation relating to the design, installation and maintenance of warm water systems. Relevant legislation and other documentation has been listed to provide guidance, however it should be noted that this may not be complete; as such it is recommended that the relevant authority be contacted where further information is required.

D.1.1 Australian Capital Territory

- Planning and Development Act 2007
- Public Health Act 1997
    - The Cooling Towers, Evaporative Condensers and Warm Water Storage Systems (Specialised Systems) Code of Practice 2005. (Public Health Act 1997).
- Water and sewerage Act 2000
- Water and Sewerage Act 2000

For further information see:

- Legislation - legislation.act.gov.au
- Plumbing - planning.act.gov.au
- Health - health.act.gov.au

D.1.2 New South Wales

- Plumbing and Drainage Act 2011
- Plumbing and Drainage Regulation 2012
- Public Health Act 2010
- Public Health Regulation 2012
- Public Health (Microbial Control) Regulation 2000
- Public Health Regulation 2012 – Part 2 Legionella Control
    - Warm Water System – Installation inspection Checklist
    - Warm Water System – Maintenance inspection Checklist
    - Microbial Sampling - Warm Water Systems Including Thermostatic Mixing Valves
        - Notification of installed water cooling system or warm water system.
    - NSW Code of Practice for the Control of Legionnaires' Disease 2004
    - NSW Health
        - Part A - Approval specification for operational testing of thermostatic mixing valves for use in non-domestic buildings in New South Wales.
        - Part B - Approval specification for operational testing of warm water generating systems not incorporating thermostatic mixing valves for use in non-domestic buildings in New South Wales.
- Policy Directive Water - Requirements for the Provision of cold and heated water Jan 2015
- Policy Directive Water - Requirements for the Provision of cold and heated water Feb 2015

For further information see:

- Legislation - legislation.nsw.gov.au
- Plumbing - fairtrading.nsw.gov.au
- Health - health.nsw.gov.au

D.1.3 Northern Territory

- Public and Environment Health Regulations 2011

For further information see:

- Legislation - nt.gov.au
- Plumbing - plumberslicensing.nt.gov.au
- Health - health.nt.gov.au

D.1.4 Queensland

- Plumbing and Drainage Act 2018
- Plumbing and Drainage Regulation 2019
- Queensland Plumbing and Wastewater Code
- Public Health Act 2005
    - Design Guidelines for Queensland Residential Aged Care Facilities
    - Health infrastructure requirements, Volume 1

For further information see:

- Legislation - legislation.qld.gov.au
- Plumbing - hpw.qld.gov.au
- Health - health.qld.gov.au

D.1.5 South Australia

- Development Act 1993
- Development Regulations 2008
- South Australian Public Health Act 2011
- Public Health (Legionella) Regulations 2013
    - Public Health Fact Sheet #303 Is my heated water system captured under the Legionella regulations?
    - Public Health Fact Sheet #304 Decontamination of high risk manufactured water systems
    - Guidelines for the Control of Legionella in Manufactured Water Systems in South Australia 2013

For further information see:

- Legislation - legislation.sa.gov.au
- Plumbing - sa.gov.au
- Health - health.sa.gov.au

D.1.6 Tasmania

- Building Act 2016
- Building Regulations 2016
- Plumbing Regulations 2016
- Public Health Act 1997
    - Laboratory Guidelines for Notifiable Water Contaminants 2019.
    - Guidelines for the Control of Legionella in Regulated Systems 2012. (Public Health Act 1997)

For further information see:

- Legislation - thelaw.tas.gov.au
- Plumbing - justice.tas.gov.au
- Health - dhhs.tas.gov.au

D.1.7 Victoria

- Building Act 1993
- Building Regulations 2006.
- Plumbing Regulations 2008
- Public Health and Wellbeing Act 2008
- Public Health and Wellbeing Act 2008 – News Bulletin – Information for aged care, health services, health service establishments, registered funded agencies, correctional services and commercial vehicle washes
- Public Health and Wellbeing Regulations 2009
- Victorian Authority Technical Solutions Sheets
    - 6.01 Hot Water Plumbing - Achieving Hot Water Delivery Temperatures Dead Ends
    - 6.03 Hot Water Plumbing – Heat Trace Cables in Warm and Hot Water Systems
    - 6.11 Hot Water Plumbing - Warm Water Systems

For further information see:

- Legislation - legislation.vic.gov.au
- Plumbing - vba.vic.gov.au
- Health - health.vic.gov.au

D.1.8 Western Australia

- Health Act 1911
- Code of practice Prevention and control of Legionnaires' disease 2010. (Occupational Safety and Health Act 1984 & Mines Safety Act 1994).
- Health (Air-handling and Water Systems) Regulations 1994
- Occupational Safety and Health Act 1984
    - Technical Note – Water Temperature

For further information see:

- Legislation - slp.wa.gov.au
- Plumbing - commerce.wa.gov.au
- Health - health.wa.gov.au