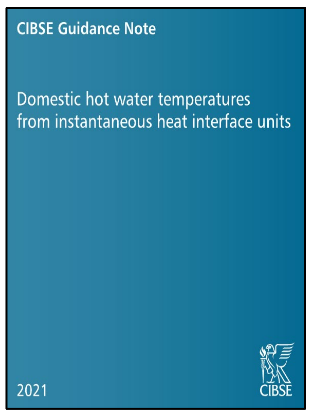
THE HEAT IS ON HOT WATER (Part 2)

by Steve Vaughan, Technical Director, AECOM

Introduction

Following the previous SoPHE Journal publication in 2020, this article provides a recap and highlights aspects of Public Health Engineering design that should be considered when applying guidance within CIBSE CP1 (Heat Networks) and CIBSE Guidance on Instantaneous domestic hot water delivery from HIUs (CIBSE Guidance Note). As we strive to combat climate change and overcome the related technical challenges it is imperative that we design to maintain water hygiene and deliver efficient public health systems designs that can achieve optimal operational efficiency.



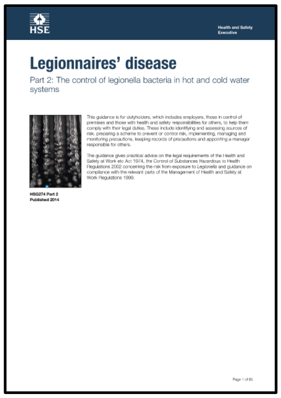
Although there have been no further updates to applicable guidance and legislation at this time, CIBSE Guide G is currently being updated and will include extensive revisions to the domestic water systems sections.

Control of legionella within domestic water systems

It is a common industrywide approach to consider temperature regime as the primary method of legionella control. However, the Health and Safety document HSG 274 Part 2 does in fact state two options that can be adopted as follows:

- Temperature Regime i.e. keeping the cold below $20^{\circ}C$ and the hot at least $50^{\circ}C$ at outlets and where stored DHW at minimum of $60^{\circ}C$ or
- Biocide treatments: Four options are listed but there are others.

Note: The document also references ultraviolet disinfection as a supplementary method for point of use applications which is not discussed in this article.



HSE

Health and Safety Executive

Legionnaires' disease

Part 2: The control of legionella bacteria in hot and cold water systems

This guidance is for dutyholders, which includes employers, those in control of premises and those with health and safety responsibilities for others, to help them comply with their legal duties. These include identifying and assessing sources of risk, preparing a scheme to prevent or control risk, implementing, managing and monitoring precautions, keeping records of precautions and appointing a manager responsible for others.

The guidance gives practical advice on the legal requirements of the Health and Safety at Work etc Act 1974, the Control of Substances Hazardous to Health Regulations 2002 concerning the risk from exposure to *Legionella* and guidance on compliance with the relevant parts of the Management of Health and Safety at Work Regulations 1999.

HSG274 Part 2
Published 2014

Page 1 of 85

There are pro's and con's to both methods but it is worth noting some of the key points:

Temperature regime:

- No residual effect, unlike many biocide treatments.
- Some waterborne pathogens are not always controlled by temperature regime
- The proliferation of scale within a water system disproportionally increased as delivery temperature is raised. Scale can harbour food source for bacteria such as legionella

Biocide treatment:

- Multiple solutions available
- Most have a residual effect (this varies)
- Specific biocides can be used to target particular waterborne bacteria
- Some bacteria may become resistant to specific biocides
- Some biocides have compatibility issues with pipework materials
- Health and safety issues for the handling/storage of chemicals is critical with some systems

DHW delivery Temperatures (residential with instantaneous DHW generation)

Regarding instantaneous DHW delivery temperatures (for residential applications), the common and historic design approach has been to select 55ºC for DHW delivery from an instantaneous hot water generation unit (such as HIU). In the past there has been some conflict/confusion with regard to acceptable temperature (often confusion with temperatures required for DHW storage arrangements).

Delivery at a maximum 50°C is not something new, indeed it is stated in many documents including BS EN 806-2, BS 8558, BS 8580, BS 6465 and IoP Guide but is now clearly defined (with constraints) in the following guidance:

- CIBSE CP1 Heat Networks: Code of Practice for the UK and
- CIBSE Guidance Note: Domestic Hot Water Temperatures From Instantaneous Heat Interface Units

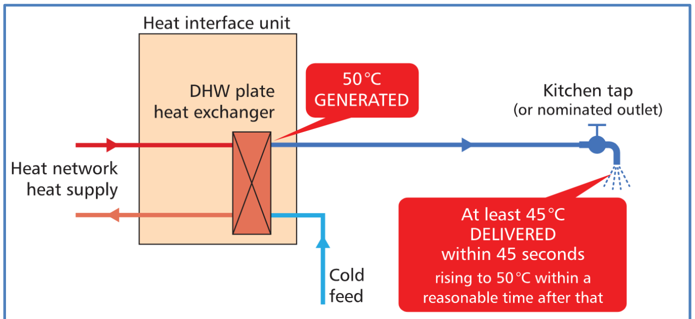


Figure 29 DHW temperature *generated* by an instantaneous HIU versus the service actually *delivered* to the consumer

Figure 29 (from CIBSE CP1) above indicates the minimum requirements for low risk residential applications.

The main driver for clarifying this lower DHW generation temperature are the thermal limitations set-out within CIBSE CP1. With the primary district heating distribution set at 60°C it is not possible to provide stored DHW without supplementary energy input (such as electric immersion). Generating DHW temperatures at 50°C is also beneficial to heat pump efficiencies, as well as reducing system losses and space heat gains.

The HSE were also consulted and defined a lower risk system (with regard to legionella) as explained in CIBSE Guidance Note as follows:

5.2.2 Typical application of a low volume instantaneous system

It is important that a risk assessment should include not only an analysis of the proposed system, but also an analysis of the expected users and usage patterns. An example of a lower risk scenario is described below.

Lower risk scenario

This scenario has been agreed with the HSE as a lower risk system.

— Block of flats served by communal heating system and communal boosted cold water system.

— Each dwelling/flat has its own low volume HIU to generate instantaneous hot water (System Type 2 – see Figure 1).

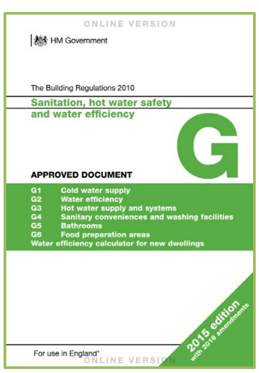
— There is no stored hot water, and each HIU contains less than 15 litres of water (as per HSG274 Part 2, paragraph 2.68).

Technical Constraints

Scalding risk

At 45°C and above there is a risk of scalding therefore Requirement G3(4) of building regulations 2010 states:

> *"The hot water supply to any fixed bath must be so designed and installed as to incorporate measures to ensure that the temperature of the water that can be delivered to the bath does not exceed 48 °C.'* The common approach is to provide a TMV to limit delivery temperature to 48°C for the bath fill."



A recognised standard for TMV certification is the BuildCert TMV2 scheme (TMV3 for healthcare) which requires an "approach temperature" (the differential temperature between DHW supply and blended outlet temperature) of minimum 10°C DHW supply. Therefore this will limit blended outlet temperature to 40ºC. This aligns with NHBC temperatures for baths, showers and wash basin taps that are all stated with a 40ºC requirement, although it is only the bath fill that has a statutory requirement (Building Regulations) to limit to maximum of 48ºC. With a DHW delivery temperature set at a maximum of 50ºC the scalding risk is also minimised throughout the domestic water installation, particularly where wash hand basins and sinks are not provided with TMVs.

The CIBSE Guidance Note also addresses the challenge relating to providing higher blended outlet temperatures which would reduce the approach temperature across the TMV. If this is less than 10ºC the secondary function of shutting off the blended DWH supply (to appliance) does not reliably operate in the majority of TMVs available on the market. However, this can be overcome by significantly reducing the risk of only cold water isolation with an appropriate pipework and valving arrangement as detailed below:

Guidance Note: Domestic hot water temperatures from instantaneous heat interface units

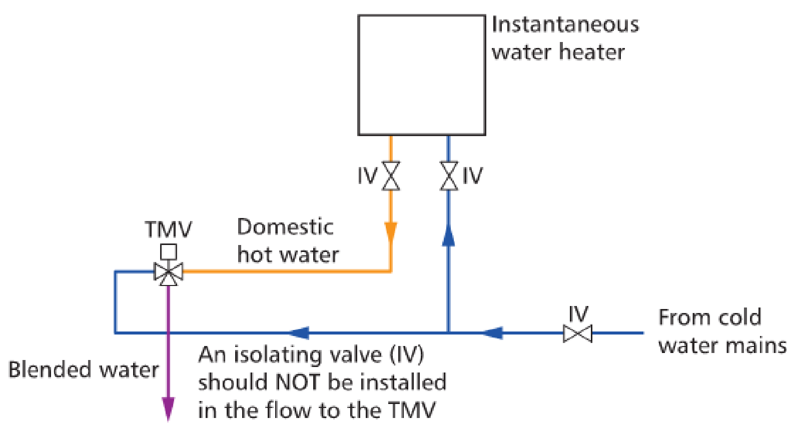


Figure 2 Pipework arrangement to prevent hot water bypass in event of cold water failure

Kitchen (sink) hot water supply

Kitchen sink supply water temperature was also investigated, with many manufacturers testing and promoting very low temperatures for dishwashing; between 23 – 40ºC is often now part of brand marketing strategy.

Therefore there is a current market trend progressing which is also driving down the temperature, fuelled by the need to reduce energy consumption.

TMV warrant

With the majority of TMVs on the UK market having approval in accordance to TMV2/TMV3 Certification there is a potential risk that manufactures will not provide a warranty if DHW design/delivery parameters are not in compliance with their test criteria, particularly as DHW supply temperature of 50°C does not comply with the parameters of TMV2 certification.

Some manufactures are however able to provide the necessary warranty but it is critical to identify this requirement at an early design stage.

Where shower valves are also installed it should not be overlooked that these may also be TMV2/TM2 certified therefore the same warranty issues will apply.

An interesting point to note here is that where gas combinations boilers are installed they are often are set to deliver DWH at below 50°C and do not appear to have caused historic problems with TMVs or shower valves within the residential sector.

Future applications

Moving beyond the residential sector there several points that are transferable to, for example commercial and even healthcare.

Delivering a lower DHW temperature to other sector applications is viable as part of a robust design, particularly where the operation and maintenance regime will be well managed and monitored, such as within healthcare sector. Considering simplified design solutions, using more local point of use instantaneous water heaters for example has the potential to improve system efficiencies, water hygiene and scalding safety.

Controlling legionella (and potentially other waterborne bacteria) by biocide as the primary water hygiene method (rather that temperature regime), is an option that should be considered. Although HTM04-01: Safe Water in Healthcare Premises Part A (a guidance document) states that temperature regime is to be maintained the fact that this regime has no residual effect, increases the complexity of the system (with multiple TMV's, valves, strainers and potential dead legs at lower temperatures) are important factors to be considered.

Throughout HTM04-01 there are references the concerns relating to complex domestic water systems, the potential sources for legionella proliferation, as well as acknowledging the challenges in maintaining temperature regime. Specific clauses worthy of reference are detailed below:

- *. . . . .Strainers can be a source of Legionella bacteria and should be included in routine cleaning, maintenance and disinfection procedures (HTM04-01 clause 8.4)*

- *. . . . . Because of the complexity of hot and cold water distribution systems and the difficulty of maintaining a temperature control regime in some healthcare facilities, this guidance suggests that additional chemical, physical and other water control methods that have been shown to be capable of controlling microbial colonisation and growth may also be considered. (HTM04-01 page .v)*

Guidance Document HTM04-1 also recognises that maintaining cold water below 20^{o}C is often problematic, with the parameters for temperature regime potentially being breached before the cold water is even distributed throughout the building, subsequently alternative biocide measures may already be necessary. The related clauses are as follows:

- *9.4 Currently there is no upper limit standard for drinking water temperature in European or domestic legislation. In normal circumstances temperatures should be delivered below 20°C but there is growing evidence that supply temperatures may rise above 25°C in summer months. Coupled with improvements in building thermal performance and climate change, rising cold water supply temperature is likely to become more problematical. The design aim should be to ensure that cold water temperature draw-off is as close to the supply temperature as possible.* (HTM04-01 clause 9.4) See also paragraphs 2.55–2.56 from HSG274 Part 2.

- *Cooling* (domestic cold) *water that may have been previously at a temperature conducive to Legionella growth will not reduce the risk of infection.* (HTM04-01 Note on page 42)

With regard to scalding risk, HTM04-01 states this should be a "never" event as detailed below:

- *NHS England's never event policy framework defines never events as serious, largely preventable patient safety incidents that should not occur if the available preventable measures have been implemented by healthcare providers. On the list of never events is scalding of patients. . . . . .* (HTM04-01 clause 0.18)

Therefore if the DHW system is designed to deliver, for example a maximum of 43°C then the scalding risk from misuse or a component failure is avoided.

Summary

It is possible to lower the DHW delivery temperature to 50°C (or lower) and maintain water hygiene.

Primary heating distribution (LTHW) temperatures would be significantly reduced which will also have a positive impact on centralised plant energy requirements, reduces distribution losses smaller pipework sizes and reduces the potential for building overheating.

Reduced LTHW temperatures also brings the opportunity to efficiently use low grade reclaimed heat sources and alternative heat generation plant such as Air Source Heat Pumps.

There are now many biocide treatment options available (more than currently stated in HSE documentation) that can be considered as primary methods of legionella control. However it is important to understand the constraints.

As with all complex engineering challenges, further challenges emerge as we delve further into this subject. Below are some of these issues:

- If biocide dosing is to be adopted as the primary method of legionella control then it is critical that the water treatment programme is properly monitored, maintained (relating to both functionality and health and safety aspects). More rigorous system monitoring is likely to be necessary. It may not be suitable or practical to adopt this approach on some projects, particularly where there won't be onsite facilities management teams (unlike healthcare projects for example). But on the other hand, there no doubt some installations that only use temperature regime as the legionella control method that repeatedly do not achieve the statutory requirements of temperature regime and so a biocide treatment is added to resolve potential water hygiene issues.

- Additional filtration methods may also need to be considered, such as pre-tank filtration to reduce the risk of organic material entering the system.

- System design should be carefully considered. Avoiding oversizing of pipework distribution to ensure water flow velocities are optimal to reduce the risk of biofilm build-up as well as unnecessary pipework water volumes.

- Consider local point of use DHW generation units (multiple) instead a whole centralised systems. Maintaining temperature regime for applications where stored water is required and local instantaneous to other areas, for example.

- Other methods of legionella control such as titanium oxidisation, Ozone or Ultraviolet disinfection may have useful applications. Although some methods provide no residual effect, they may be useful for point of use applications.

Looking ahead

The design principles and options for hot water generation has and will continue to change at an unprecedented pace.

Whether to meet government targets for Net Zero Carbon, reduce energy consumption and the reliance on fossil fuels it is inevitable that these challenges will impact on DHW delivery temperatures as well as the methods that we use to generate domestic hot water.

This is likely to impact on the methods of legionella control and the health and safety issues relating to scalding risks.

With the emergence of ambient loop primary water distribution systems, the opportunities for heat reclaim from for example, waste water systems or solar thermal systems will increase.

Ambient loop systems also lend themselves to apartment based water to water heat pumps and DHW storage. However, technology needs to continue to advance to improve efficiencies without the need to add "in series" air source heat pumps with water to water heat pumps or electric immersion heaters to achieve acceptable DHW storage temperatures.

There are air source heat pumps available for direct DHW generation which can efficiently deliver adequate temperatures (such as CO_2 heat pump units) but technology and manufacturers needs to advance to provide more options to improve efficiencies for air source Heat Pumps or water to water heat pumps via closed loop LTHW systems which are coupled to central space heating and DHW storage.

This fundamental concept to lower instantaneous hot water delivery temperature and move away from the industry standard of using temperature regime as the primary method of legionella control within domestic hot water systems is one of the biggest challenges we are facing within the industry for a long time.

The biggest risk we face is climate change and we have the tools, knowledge and expertise to slow the change without increasing the risk to our health. We must take on such challenges without delay.

Steve Vaughan *is Technical Director at* ***AECOM*** *as well as a member of CIBSE SoPHE Technical and Education steering groups.*