Legionella Risk In Domestic Water Services

Richard Beattie

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AECOM

Contents

Conditions for Legionella infection

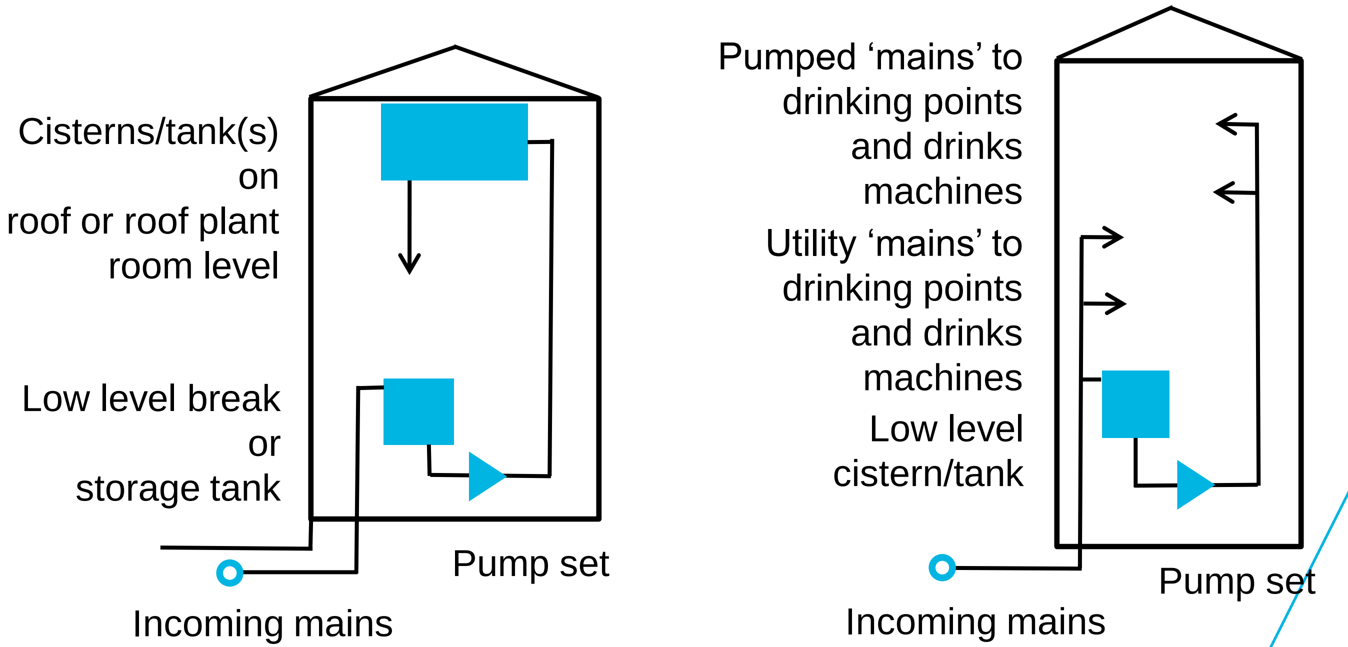
1. Temperature between 20°C and 45°C;
2. Potential for water aerosols to be formed/airborne;
3. Water being stored and/or re-circulated;
4. Presence of deposits/ nutrients, such as sludge, organic matter etc;
5. Susceptible host;
6. Legionella bacteria.

Reference: HSE L8

Application and designation	Mixed water temperature (point of discharge °C)
Bidet	38 max.
Shower	41 max.
Washbasin	41 max.
Bath 44°C	44 max.
Bath 46°C	46 max.
Diverter Bath/shower	Bath 44 max, shower 41 max.
Diverter Bath/shower	Bath 46 max, shower 41 max

Reference: HTM 04-01 D08

Installations – Cold water system types

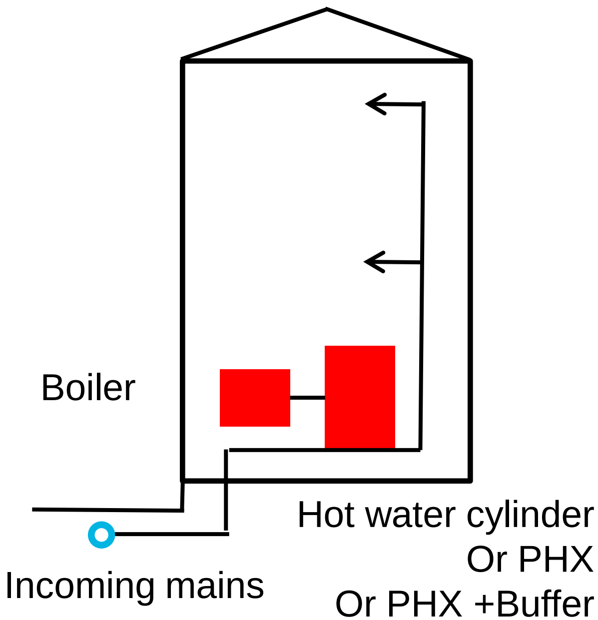


Images from* Plumbing Engineers Design Guide IoP 2002

(A) Combined pump and gravity (B) Mains water for drinking

Installations – Hot water systems

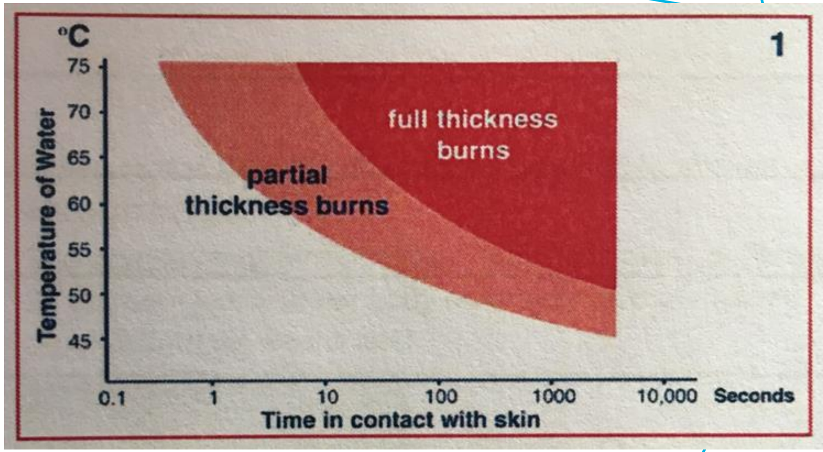
Typical hot water generation



Scalding

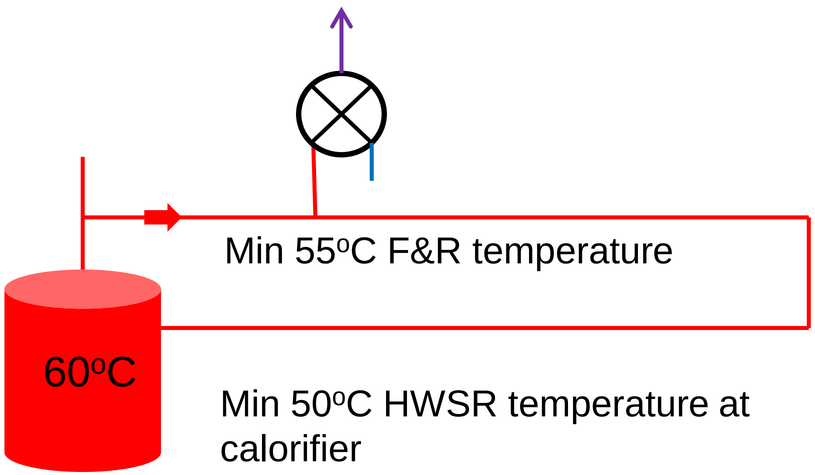
Celsius Temperature	2nd Degree Burn	3rd Degree Burn
45º	2 hrs	3 hrs
47º	20 min	45 min
48º	15 min	20 min
49º	8 min	10 min
51º	2 min	4.2 min
55º	17 sec	30 sec
60º	3 sec	5 sec

Exposure time to receive a severe burn



Celsius Temperature	minutes
50º	111
54º	27
58º	6

Legionella kill time, Dennis *et al*, (1984)



*TMVs should not be installed in series with mixing taps (manual or thermostatic)

Reference: HTM 04-01 B

TMVs

Build Cert Provides an independent third party approval

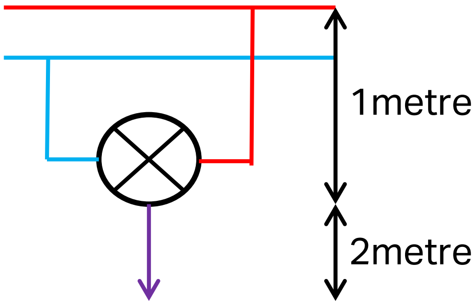
There is a three tier scheme within build cert, these are:

Type 1 TMV – Communal Blender,
this has no fail safe or temperature stop

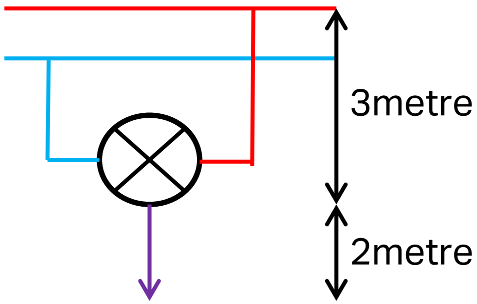
Type 2 TMV – conforms to BS EN1111 or 1287,
this has a fail safe

Type 3 TMV – valve approved to NHS Document D08,
this has a fail safe

Note – approved TMVs only, i.e. WRAS Approved
&
Preferable that thermostatic mixing devices are integral to the mixed outlet, to offer method of temperature and flow control



Installation dia' for single outlet HTM04-01:
Total length 3metres

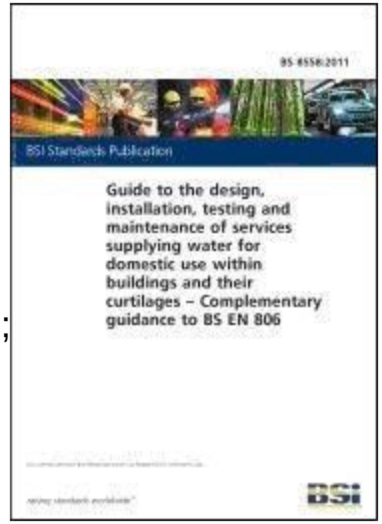


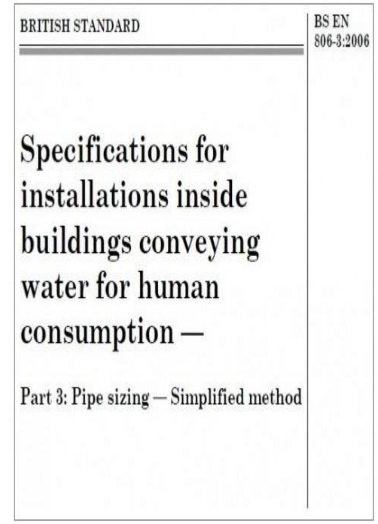
Installation dia' for single outlet non healthcare:
Total length 5metres

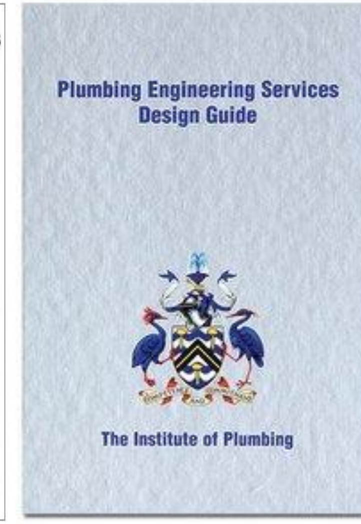
Pipe sizing

Loading units: IoP, BS8558 and BS EN 806, CIBSE Guide G

1. Probability theory;
2. Time between uses of an appliance;
3. Duration of use;
4. And flow rates when in use.



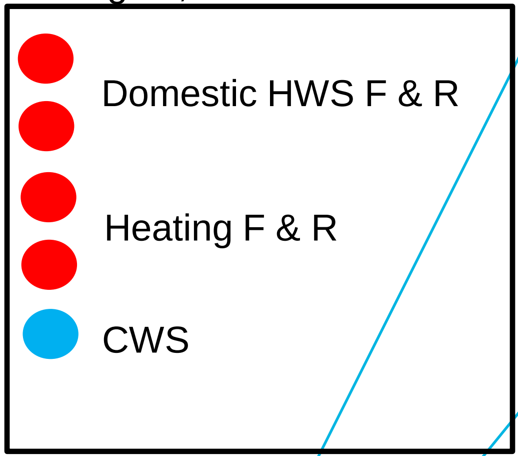




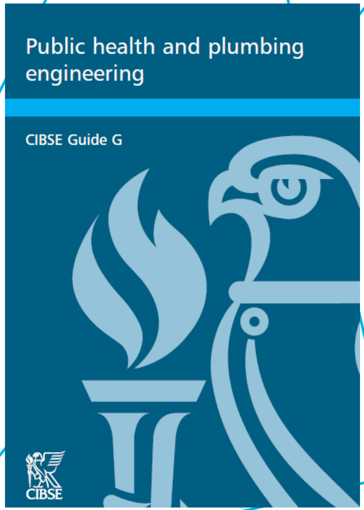
Cold water pipework runs:

1. CWS pipework runs should be designed to reduce heat gain;
2. Not run above or near heat sources;
3. Should run in a different ceiling space;
4. If (3) above is not possible, separate **HWS** and **CWS** as far as possible.

Reference: HTM 04-01 A



Stacking of pipework



Domestic cold water systems– Research from academia

Webster 1972: Generalized binomial distribution function

Courtney 1976: Probabilistic model

Konen 1980 and Holmberg 1981: Dimensioning formula

Murakawa 2004: Development of the calculating method for the loads of water consumption in restaurant

Takata 2004: Development of the calculating method for the loads of cold and hot water consumption in office buildings

Blokker 2006: Simulation of water demands provides insight

Alitchkov 2007: Statistical method for estimation of peak water demands in supply systems for buildings

Saarekonno 2007: Domestic water consumption and its irregularity

Goncalves 2008: Model of design flow rate in water submetering systems using fuzzy logic and monte carlo method.

LUNA (Loading Unit Nominalisation Assessment) - CIBSE

And many many more.........

Cold water storage tank sizing

The volume of stored water is obtained from:

$$Storage\ volume = \begin{pmatrix}\text{number of}\\ \text{persons}\end{pmatrix} x \begin{pmatrix}\text{litres per}\\ \text{person}\end{pmatrix} x \begin{pmatrix}\text{number of}\\ \text{days' storage}\\ \text{(or \% of 1 days supply)}\end{pmatrix}$$

Storage volume = basis of peak demand and rate of make-up from supply

Type of building	Demand (litre) CIBSE Guide G	Demand (litre) SHTM04:01	Basis of demand
Hospitals			
District general	600	Acute 299-978	Bed
Surgical ward	250	Specialist 319-531	Bed
Medical ward	220	Long stay 180-306	Bed
Schools			
Nursery	15		Pupil
Primary	15		Pupil
Secondary	20		Pupil
Offices			
With canteen	45		Person
Without canteen	40		Person
Hotels			
Budget	135		Bedroom
Travel Inn	150		Bedroom
Sports Facilities			
Swimming pool	20		Person
Field sports	35		Person

Table 1: Recommendations of water storage quantities.

www.sduhealth.org.uk

&

http://hefs.hscic.gov.uk/

Table 2: Recommendations of water percentage stored.

Type of Building	% of the daily demand
Hospital	50%
Schools	50%
Offices	0-50%
Hotels	50%
Sports Facilities	0-25%

Reference: CIBSE Guide G, Institute of Plumbers

Legionella/bacteria

The Chartered Institute of Building Services Engineers Technical Memorandum TM13 '*The Control of Legionella'* identifies the following as temperatures for Legionella growth:

1. Dormant; $0^{o}C$ to $20^{o}C$ (VBNC);

2. Will multiply; $20^{o}C$ to $45^{o}C$;

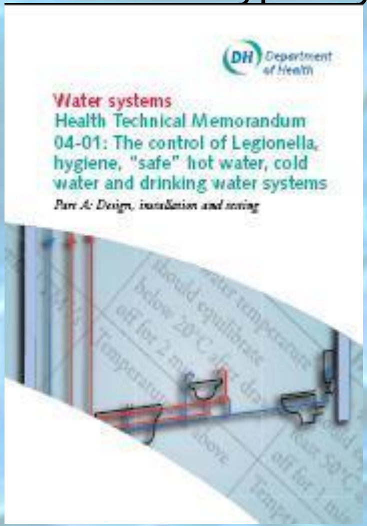
3. Will not multiply and will die in time; $50^{o}C$ to $70^{o}C$;

4. Not active; $70^{o}C$ to $100^{o}C$.

The most favourable temperature, based on empirical data suggests that the ideal microbial growth and proliferation is $37^{o}C$.

Legionella/bacteria

Appliances such as, WC's, drinking fountains, bib taps and urinals are not typically associated with aerosol sprays.



Certain groups of people are known to be more susceptible:

- over 45 year olds;
- smokers, alcoholics;
- diabetics;
- immune compromised and
- cancer or respiratory or kidney disease.

Obvious building where infection would prove catastrophic and potentially fatal is a hospital. The Department of Health have the Technical Memorandum HTM 04-01

BS 8580:2010 provides details of how to conduct a Legionella risk assessment.

Other standards:
ASHRAE 188P, Guideline 12: 2014
WHO, Water Safety in Buildings, Legionella and the prevention of Legionellosis

Water quality standards & regulation’s

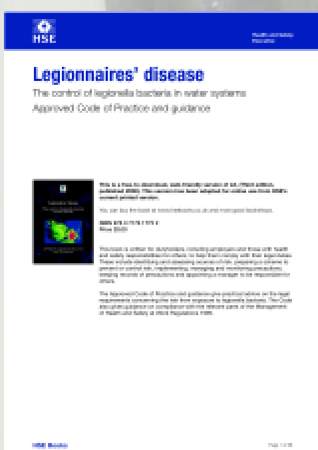
1. CIBSE TM13 – ***‘Minimzing the risk of Legionnaires disease’*** and BS8580:2010 - ***‘Water quality- risk assessments for Legionella control’*** requires CWS to be below $20^{o}C$ after turned on 120s;

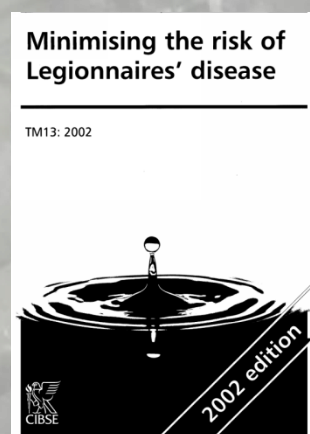
2. L8: Cold water to be stored at **<$20^{o}C$**; Cold water to reach outlets **<$20^{o}C$** within **2minutes.**

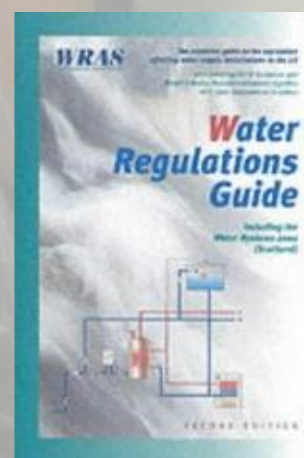
3. L8: Hot water to be stored at **$60^{o}C$**, reach outlets **>$50^{o}C$** within **30 sec, >$55^{o}C$** within **1 minute.**

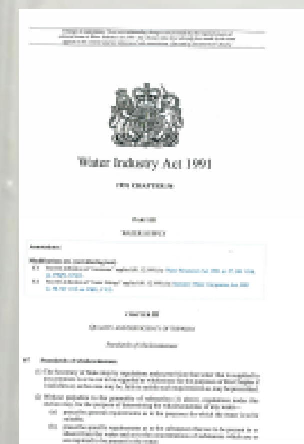
4. L8 requires temperatures between $20^{o}C$ and $45^{o}C$ to be avoided.

5. HTM04 01 A: Temperature of no greater than **$2^{o}C$** above water tank at outlet within **2minutes.**









Potential causes of cold water overheating

From the mains water supply network:

1. Mains water authorities should have a requirement to provide water less than 20^{o}C;
2. Rural location of a building on a radial service;
3. Burial depth of incoming water;
4. MWS storage tanks located above ground or in semi-buried configurations.

From water conservation measures:

1. Introduction of rainwater, grey water, black water recycling;
2. Use of percussion taps and low-flow fittings;
3. Lack of regular flushing of the system.

Potential causes of cold water overheating

<u>From design and management:</u>

1. Possibility of over-sizing cold water storage tanks;
2. Reduced periods of occupancy;
3. Heat generating plant and equipment within ceiling voids;
4. DCWS pipelines should be kept minimum distances from LTHW pipelines;
5. Water storage tank location;
6. Lack of quality control of legislation in regards to thermal insulation of plant and equipment;
7. Insufficient space between heat generating plant and cold water storage tanks;
8. Lack of domestic water draw-off due to unoccupied spaces;

Potential causes of cold water overheating

Design and management continued..

9. If the occupancy levels in the building after handover is less than envisaged at design stage a lack of domestic water draw-off due to unoccupied spaces and infrequently used outlets may cause elevated temperatures;

10. Ease of access for maintenance;

11. Poor maintenance associated with periodic system flushing;

12. The use of flexible connections which could potentially harbour biofilm;

13. Insufficient consideration of system dead legs;

14. The end user not implementing risk assessments and procedures to control the risk of Legionella.

Potential mitigation measures

1. Improve quality control with regards to thermal insulation;
2. Controlled flush/bleed valves;
3. Enhanced void ventilation rates;
   A. Low and high level grilles;
   B. Introduce mechanical vent if necessary;
4. Introduce chlorine dioxide CL02 dosing system- would address bacteria not temperature;
5. Increase thickness of insulation on CWS;
6. Introduce manual flushing strategy;
7. Provide a delayed action adjustable height ball valve within storage tank to allow stored volumes to be adjustable;
8. Install a small refrigeration system with pumps and plate heat exchanger to chill water within CWS tank;

Potential mitigation measures

9. Ensure pipe sizing is carried out as close as possible to the expected demand to ensure good flow, to minimize stagnation and potential heat gain;
10. Implement an appropriate management strategy which includes manual or automatic flushing;
11. External MWS pipework between site boundary and plantroom should be a depth of 750mm;
12. Isolate and drain down one cold water storage tank section if it is a sectional tank as in hospitals, this will improve turnover-to-demand;
13. Encourage clients to include post occupancy evaluation, which can be shared with the industry to help inform trends and future updates to standards and guidance.
14. The addition of chlorine dioxide CL02 dosing system to the domestic water services systems; (will not rectify water temperature).
15. Ensure appropriate controls and sensors are provided for monitoring domestic cold water consumption and cold water temperatures throughout the system;
16. Consider reducing cold water storage levels in buildings appropriate to the building type and anticipate demand (reduce from 24hr to 12hr storage);
17. Incorporate a ‘soft landings’ approach to help building users and operators adjust to their new facility and help them understand the building and associated systems design intent and operation;

Potential mitigation measures

18. Include seasonal commissioning in the contract to allow the systems to be adapted to seasonal variations and changes in user need;

19. Industry review of current standards in relation to the design and sizing of cold water tanks, drawing on the experience of industry professionals and available live data across a wide range of building types and sectors;

20. Industry and academic research should investigate the variability of peak consumption over an extended period of time to allow for reassessment of current design codes;

21. Data/Knowledge sharing from live in use buildings.

Summary

<u>We have reviewed here:</u>

1. Basics of domestic water services;
2. Current water standards and regulations;
3. MWS should be kept below 20^{o}C;
4. Potential causes of pipework heat pick-up and potential mitigation measures;
5. Suggestions for maintaining a healthier water supply;
6. Suggestion for promoting a culture of collaboration and knowledge sharing with the goal of benefitting the building services industry and our clients.

**The successful control of Legionella is a combination of good technical engineering design and client side control management*.

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Richard.Beattie@aecom.com

Thank You