5.2.1.8 Valve chambers

Surface boxes should be provided to give access to operate valves and hydrants. They should be supported on concrete or brickwork, which should not be allowed to rest on the pipes, transmitting loads to them, allowance being made for settlement.

Alternatively, vertical guard pipes or precast concrete sections should be provided to enclose the spindles of valves. Brick or concrete hydrant chambers should be constructed of sufficient dimensions to permit repairs.

5.2.1.9 Contamination

Precautions to avoid contamination of the supply pipe should be taken when making a connection. Before connection and return to service, the pipe should be flushed and, where necessary, disinfected.

5.2.1.10 Building entry

Underground pipes entering a building should do so at the level given in **4.3.34.4** (see also **4.3.38** and **4.3.39**).

Where a pipe enters a building, it should be accommodated in a sleeve that has been solidly built in; the space between the pipe and the sleeve should be filled with non-hardening, non-cracking, water-resistant thermal insulating material for a minimum length of 150 mm at both ends to prevent the passage of water, gas or vermin (see **4.3.34.3** and Figure 11).

5.2.2 Electrical bonding

No water pipe should be used as an electrode for earthing purposes, but all metal pipes should have equipotential bonding applied, which connects to the installation main earth terminal as near as possible to the point of entry into the building.

The connection should be mechanically and electrically sound and not subject to corrosion.

Main equipotential bonding should be in a position where it is accessible, may be visually observed and fitted with a warning label stating: “safety electrical connection: do not remove”.

Earthing recommendations are given in BS 7430.

Supplementary equipotential bonding may be required in special locations, e.g. bathrooms.

Electrical installation requirements are given in BS 7671.

5.2.3 Flushing and disinfection

5.2.3.1 Flushing

Every new water service, cistern, distributing pipe, hot water cylinder or other appliance, and any extension or modification to such a service should be thoroughly flushed with wholesome water before being put into service. The primary reason for this process is to remove any debris and organic matter, which encourages the growth of biofilms and subsequent deterioration of water quality. Additionally, the process removes any excess of flux, which can cause corrosion of copper pipes if left in place under conditions of low or no flow.

Larger pipes, e.g. pipes with an ID greater than 50 mm, or where contamination is suspected, should be disinfected after flushing.

5.2.3.2 Pre-disinfection flushing

At the time of construction and before the disinfection it may be necessary to leave the water in the system. Where this is the case, a regular regime of flushing should be undertaken at every outlet twice weekly. This counteracts the effect of stagnation at exposed copper surfaces, which can lead to corrosion and the onset of blue water syndrome. Depending on the quality of the local water over time, deposit of calcium salts are laid on the copper surfaces, which might negate the effects of localized corrosion.

This process is not a substitute for a full system disinfection before occupancy.

5.2.3.3 Disinfection

The timing of the disinfection process affects the water quality management of a building. Where precautions are not taken, biofilms re-colonize tanks, cisterns and pipework shortly after disinfection. The speed of recolonization depends on:

- the temperature and microbiological quality of the incoming supply water;
- the materials of construction of the tanks, cisterns and distribution system;
- the influence of temperature at specific points in the distribution system;
- the residual disinfectant concentrations retained in the distribution system on completion of the disinfection process; and
- the frequency of use of outlets.

NOTE Even materials fully compliant with Water Fittings Regulations [7] support the formation of biofilm to some extent. Different materials support differing thickness and growth rates relative to flow rate and temperature.

Where practicable, system disinfection should not be carried out until immediately before occupation. Disinfection should be carried out not more than 30 days before the start of occupancy. Once disinfection has been carried out, the system should be flushed weekly to maintain a flow of water. The design of the flushing programme should be in accordance with the HSE's *Approved Code of Practice L8, Legionnaires' disease – The control of Legionella bacteria in water systems* [N1].

Where more than 30 days elapse between the completion of system disinfection and the start of occupancy, routine flushing should be carried out to mimic occupancy. Where this flushing does not take place, the building should be representatively sampled and assessed for microbiological quality and evidence of excessive accumulation. The following tests should be carried out:

- total viable counts (TVC) measured at 22 °C;
- TVC measured at 37 °C;
- Coliform bacteria;
- Pseudomonas aeruginosa;
- Legionella (species); and
- disinfection residuals (taken concurrently with the microbiological samples).

Where the results indicate that the system has deteriorated with an increase in microbiological counts, e.g. TVC results in excess of a 2 log difference above that found in incoming mains water, corrective action should be taken.

Where Pseudomonas aeruginosa or Coliform bacteria are present, the sampling point should be flushed and retested. If positive results persist, investigation into the cause should be extended with a view to repeating the disinfection process.

Where Legionella is identified during this exercise, disinfection should be repeated.

5.2.3.4 Residual disinfection

After the disinfection process, a residual free chlorine concentration should be retained to delay the onset of biofilm formation in the system before normal use is allowed. The residual should conform to the following criteria where possible.

a) The average residual chlorine for the building across all the representative sampling points should be between 0.3 mg/L and 0.1 mg/L free chlorine.

b) Between 1% and 10% of the samples should be between 1 mg/L and 2 mg/L free chlorine.

c) The maximum residual free chlorine concentration acceptable is 2 mg/L, which should not occur in more than 1% of the distribution samples.

d) The extremities of the distribution system benefit the most from retained free chlorine residuals above 1 mg/L.

e) Cisterns should be left with a residual free chlorine concentration of 2 mg/L.

Achieving these proportions precisely might not be possible under all circumstances. Therefore acceptance of the retained residual free chlorine should be left to the professional judgement of the responsible person at the time of completion.

5.2.3.5 Disinfection

*COMMENTARY ON **5.2.3.5***

*Flushing and disinfection are not a substitute for a high degree of cleanliness during installation (see also **5.2.1.4**).*

For single dwellings and minor extensions or alterations in any premises, flushing is all that is normally recommended, unless contamination is suspected.

After flushing, systems should be disinfected in accordance with **5.2.3.6** to **5.2.3.8** in the following situations:

a) in new installations (except private dwellings occupied by a single family);

b) where major extensions or alterations have been carried out;

c) where underground pipework has been installed (except where localized repairs only have been carried out or junctions have been inserted [see **5.2.3.7**]);

d) where it is suspected that contamination might have occurred, e.g. fouling by sewage, drainage, animals or physical entry by site personnel for interior inspection, painting or repairs; and

e) where a system has not been in regular use and not regularly flushed.

Where any pipework under mains pressure or upstream of any backflow prevention device within the installation is to be disinfected, the water supplier should be informed. Chemicals used for disinfection of drinking water installations should be appropriate for public drinking water systems and in accordance with section 2.1 of Annex 2 of the Drinking Water Inspectorate's *List of Approved Products for use in Public Water Supply in the United Kingdom* [26] [11)]. The listing of a specific relevant standard for a particular disinfectant does not imply that this disinfectant is suitable or recommended for the proposed use; fitness for purpose of the chosen disinfectant should be ensured, including its effectiveness in controlling microorganisms in the proposed application.

[11)] www.dwi.gov.uk

NOTE Attention is drawn to the Water Industry Act [5] for information on contacting the relevant authority before water used to disinfect an installation is discharged into a sewer.

Where water is to be discharged into a water course or into a drain leading to the same, consent to discharge should be obtained from the appropriate authority, i.e. the Environment Agency in England and Wales, the Scottish Environmental Protection Agency in Scotland and the Department of the Environment for Northern Ireland in Northern Ireland. The sequence of disinfection should be water mains, service pipes, cisterns and the internal distribution system.

5.2.3.6 Cisterns with internal coatings

Because high chlorine concentrations and other disinfectants can adversely affect new coatings in cisterns and release chlorinated or other compounds into the water, the coating should be thoroughly cured before disinfection takes place and 50 mg/L chlorine concentration or the manufacturer's recommendation for alternative approved disinfectants should not be exceeded.

All cisterns storing water for domestic purposes should be made from or lined with material that is approved for contact with drinking water in the WRAS *Water fittings and materials directory* [27] and or supporting documentation demonstrating conformity to BS 6920 (all parts).

5.2.3.7 Localized repairs

Junctions or fittings for a localized repair inserted into an existing external pipeline should be disinfected by immersion in a solution of sodium hypochlorite containing 200 mg/L of available chlorine.

5.2.3.8 Safety

Systems, or parts of systems, should not be used during the disinfection procedure and all outlets should be marked with "DISINFECTION IN PROGRESS, DO NOT USE".

To avoid the generation of toxic fumes, no other chemicals, e.g. toilet cleansers, should be added to the water until disinfection is complete. All building users should be informed of the disinfection before it takes place. This includes those not normally in attendance during working hours, i.e. cleaners and security guards.

5.2.3.9 Disinfection procedure

5.2.3.9.1 General

The system to be disinfected should be thoroughly flushed before commencing the disinfection procedure.

For supply pipes (including unvented hot water systems off the supply pipe) after flushing, disinfectant solution should be injected through a properly installed injection point at the upstream end of the supply pipe until the disinfectant solution discharged at the downstream end of the pipeline is equal to the initial concentration; the contact period then commences.

Disinfection should be carried out via a temporary connection incorporating the appropriate backflow prevention.

5.2.3.9.2 Methods using chlorine as a disinfectant

5.2.3.9.2.1 Chlorine dioxide

Once vessels have been mechanically cleaned internally and externally, they should be disinfected by making full contact of the inner surfaces using wholesome cold water containing 21.0 mg/L chlorine dioxide (ClO_2) (see Figure 16 and Figure 17, which illustrate the more likely practical times and concentrations obtained using the equation Contact time (h) = 300/free chlorine (mg/L) graphically, which can be used as a "look-up chart" for practical application; see also BS EN 12671).

NOTE Chlorine dioxide has the advantage of being effective against biofilms.

Figure 16 **Initial free chlorine concentration and contact period for tank disinfection (see Table 13, columns 1 and 2)**

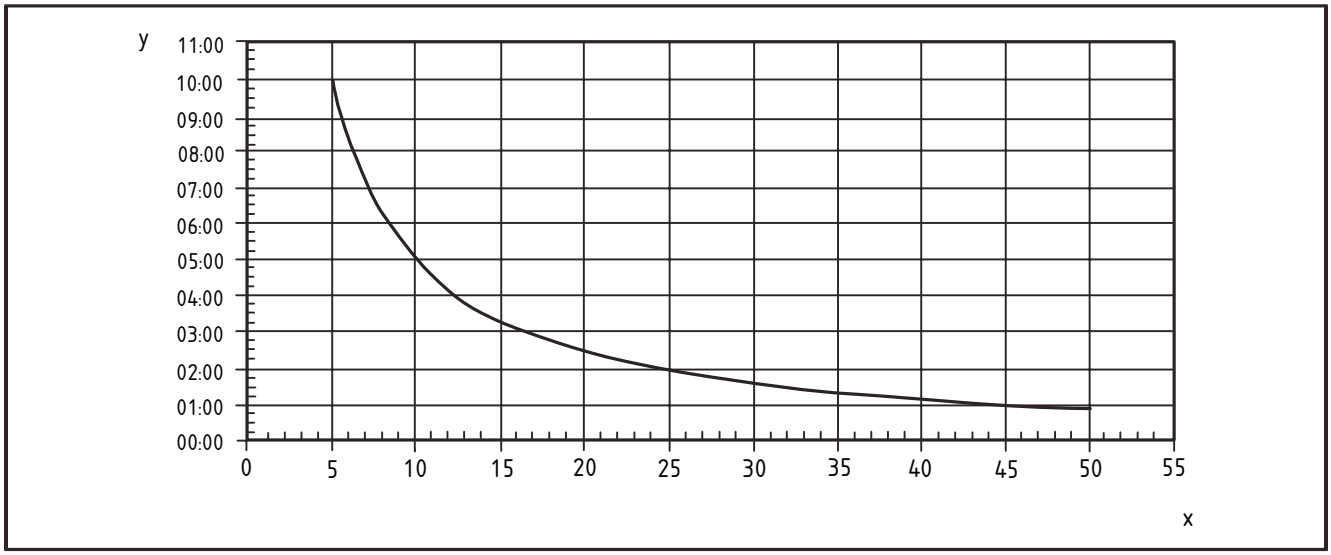
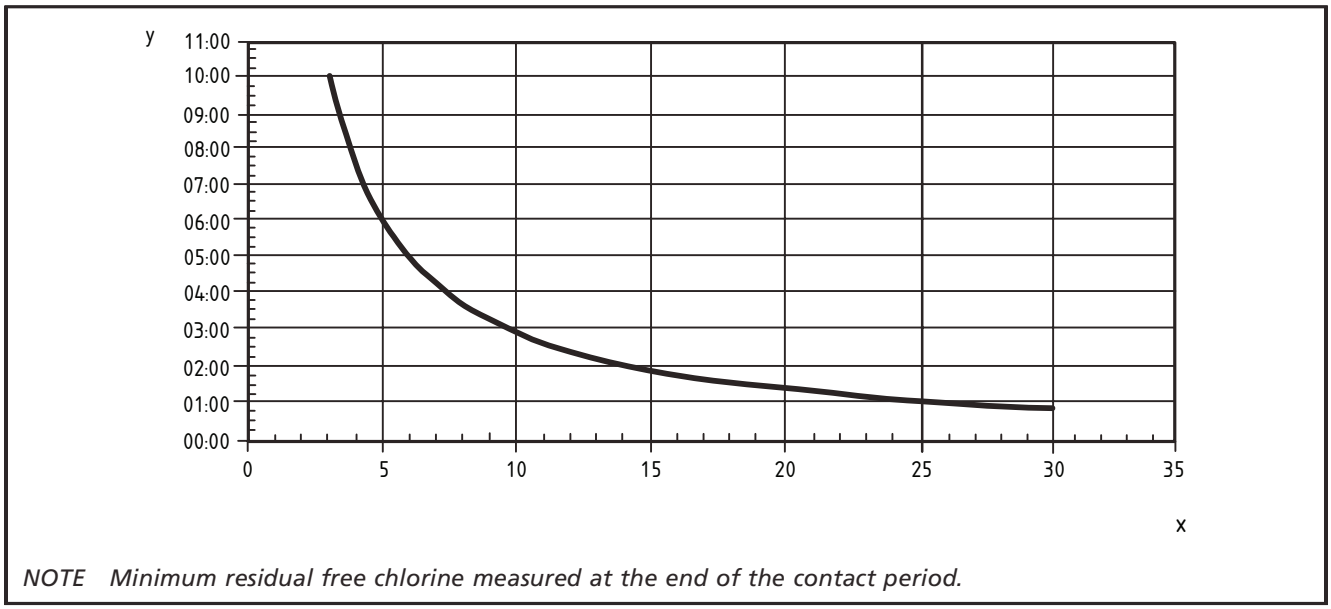


Figure 17 **Minimum residual free chlorine after contact period (see Table 13, column 3)**



NOTE Minimum residual free chlorine measured at the end of the contact period.

5.2.3.9.2.2 Free chlorine soaking

When disinfecting pillow tanks, chlorine dioxide solution should be introduced into the vessel to separate both top and bottom surfaces of the tank, while ensuring contact of the sides and agitating the surfaces by moving the solution inside the tank (walking in circles on top of the tank is a very effective method).

Another regularly used contact disinfectant is water containing up to 50 mg/L of free chlorine for the appropriate time given in Table 13 (see also Figure 16 and Figure 17). This disinfectant medium is satisfactory, but is less effective in stripping biofilm and, over time, proves more difficult to obtain a satisfactory microbiological test result.

NOTE Table 13 was constructed using data from the equation: Contact time (h) = 300/free chlorine (mg/L).

Table 13 **Chlorine contact period** [A)]

1	2	3
Initial free chlorine concentration mg/L	**Contact period** h:min	**Minimum residual free chlorine measured at the end of the contact period** mg/L
3.1	16:00 [B)]	1.9
5	10:00	3
10	05:00	6
15	03:20	9
20	02:30	12
25	02:00	15
30	01:40	18
40	01:15	24
50 [C)]	01:00	30

[A)] If the residual free chlorine measured at the end of the contact period is less than the values in Table 13, this indicates an excessive chlorine demand and poor cleaning beforehand. Where this is the case, the disinfection process should be repeated. After the allotted contact period, the loss of free chlorine should not exceed 40%.

[B)] Contact periods of greater than 16 h prove impractical under most circumstances when vessels are required for use; this equates to a minimum practical residual free chlorine concentration of 1.9 mg/L.

[C)] 50 mg/L chlorine concentration should not be exceeded to avoid corrosion risks to copper.

*NOTE 1 The information in Table 13 is reproduced using the disinfection criteria in BS 6700:1997, **3.1.10.4.1** (superseded).*

NOTE 2 The contact period commences when the entire volume, up to overflow concentration, is full of disinfectant solution at the required initial concentration.

5.2.3.9.3 Supplementary disinfection dosing

If the building system is designed to operate with the support of supplementary disinfection equipment, or if such equipment is retrofitted to an existing building, the designers and specifies of such equipment should consider:

a) the water storage capacity in the building with particular reference to the water age;

b) the concentration and type of residual disinfectant present in the supply water;

c) the natural disinfectant demand of the water;

d) the inherent quality factors attributable to the supply water that might affect the performance of the disinfectant to be added to the system;

e) the synergistic and additive effects of inherent supply disinfectant residuals and their effects on those to be added to the system;

f) the half-life of the disinfectant material to be added to the system; and

NOTE This is important for the maintenance of the minimum dose during periods of building inactivity, e.g. overnight, at weekends.

g) the effects of changes in water temperature on the efficacy of the disinfectant to be applied.

Suitable backflow protection should be incorporated upstream of the injection point.

Disinfectants do not remain stable and unchanged over the entire storage period under all circumstances of use and occupancy. Water softeners, different materials of system construction and the process by which cisterns are filled all affect the disinfectant residual achieved. These variables should be considered in the dosing regime design.

5.2.3.9.4 Location of dosing equipment

Dosing equipment should be located at points in the system where the most effective deployment of disinfectant can be achieved. Where designing supplementary disinfectant regimes, the minimum effective dose should be achievable over the minimum of a 24-hour period. Additionally, the minimum concentration should be sustained during the designed water storage period at full occupancy of a building.

At the time of building or plant commissioning, it should be demonstrated that effective doses can be maintained over the longest period of predicted building inactivity proportionate to its functionality, e.g. a hospital might demonstrate active occupancy over a weekend, an office block where water age increases over those predicted for occupancy during a working day.

At the time of commissioning, a building-wide sampling plan should be drafted and a structured monitoring exercise carried out to demonstrate the efficacy of the equipment.

Contractual variations may be necessary to accommodate for modification or refits if the building cannot be effectively tested due to low or no occupancy at the time of commissioning of dosing equipment.

5.2.3.9.5 Sampling

Samples should be:

- appropriate for the specified purpose, i.e. microbiological assessment, chemical analysis or on-site testing;
- sufficient in number to be fully representative of the distribution system, sub-branches, tanks and cisterns as well as the condition to be evaluated, e.g. completion of a cleaning process, efficacy of distribution of disinfectant; and
- taken at a frequency which is representative of the time series to be demonstrated, e.g. taking into account the growth rate of the organism when designing the monitoring scheme to check for potential microbiological colonization.

For further guidance on sampling, see BS EN ISO 5667-3, BS ISO 5667-5, BS EN ISO 19458, BS 7592 and BS 6068-6.3.

Where alternative temporary supplies are used during construction, or at other necessary times of deployment, sampling should be conducted in accordance with BS ISO 5667-21.