BS 8554:2015

BSI Standards Publication

Code of practice for the sampling and monitoring of hot and cold water services in buildings

bsi.

...making excellence a habit.™

Publishing and copyright information

Published by BSI Standards Limited 2015

ISBN 978 0 580 82872 0

ICS 91.140; 91.140.60

The following BSI references relate to the work on this document:
Committee reference EH/3
Draft for comment 14/30282433 DC

Publication history

First published September 2015

Amendments issued since publication

Date	Text affected

Contents

Summary of pages

This document comprises a front cover, an inside front cover, pages i to ii, pages 1 to 42, an inside back cover and a back cover.

Foreword

Publishing information

This British Standard is published by BSI Standards Limited, under licence from The British Standards Institution, and came into effect on 30 September 2015. It was prepared by Technical Committee EH/3, *Water quality*. A list of organizations represented on this committee can be obtained on request to its secretary.

Information about this document

It has been assumed in the preparation of this British Standard that the execution of its provisions will be entrusted to appropriately qualified and experienced people, for whose use it has been produced.

In particular, it is expected that users of this standard understand the importance of sampling using aseptic techniques.

Test laboratory accreditation. Users of this British Standard are advised to consider the desirability of selecting test laboratories that are accredited to BS EN ISO/IEC 17025 by a national or international accreditation body.

Hazard warnings

WARNING. This British Standard calls for the use of substances and/or procedures that can be injurious to health if adequate precautions are not taken. It refers only to technical suitability and does not absolve the user from legal obligations relating to health and safety at any stage.

Presentational conventions

The provisions of this standard are presented in roman (i.e. upright) type. Its recommendations are expressed in sentences in which the principal auxiliary verb is "should".

Commentary, explanation and general informative material is presented in smaller italic type, and does not constitute a normative element.

The word "should" is used to express recommendations of this standard. The word "may" is used in the text to express permissibility, e.g. as an alternative to the primary recommendation of the clause. The word "can" is used to express possibility, e.g. a consequence of an action or an event.

Notes and commentaries are provided throughout the text of this standard. Notes give references and additional information that are important but do not form part of the recommendations. Commentaries give background information.

Contractual and legal considerations

This publication does not purport to include all the necessary provisions of a contract. Users are responsible for its correct application.

Compliance with a British Standard cannot confer immunity from legal obligations.

1 Scope

This British Standard gives guidance and recommendations for investigative and planned collection of hot and cold water samples during the life of a building, including sampling locations and the selection of laboratory or on-site testing for those samples.

This standard covers sampling from wholesome water systems and water used for make-up where the water is used for immersion or contact, such as spas, swimming pools and therapeutic units. Wholesome water services are systems designed to provide hot and cold water, including water for cooking, drinking and food preparation or washing.

Recommendations are given for sampling for the following reasons:

a) one-off sampling for compliance, to evaluate whether the water quality conforms to regulations, guidance, specifications or imposed conditions;

b) ad hoc sampling for verification, to provide assurance that the water being used is suitable for its intended use;

c) sampling for investigation – searching for the cause of concerns or complaints about water quality;

d) random sampling – economically-driven or voluntary sampling used to help confirm or otherwise that water hygiene controls remain effective; and

e) identification and implementation of schemes for commissioning, routine and investigative monitoring of water quality.

This standard is not applicable to the sampling of water following outbreaks of Legionnaires' disease or for the sampling of water from closed systems.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

Standards publications

BS 7592:2008, *Sampling for Legionella bacteria in water systems – Code of practice*

BS 15883, *Washer-disinfectors*

BS EN ISO 5667-1, *Water quality – Sampling – Part 1: Guidance on the design of sampling programmes and sampling techniques*

BS EN ISO 5667-3, *Water quality – Sampling – Part 3: Preservation and handling of water samples*

PD 855468, *Guide to the flushing and disinfection of services supplying water for domestic use within buildings and their curtilages*

Other publications

[N1] AUTOMATIC VENDING ASSOCIATION OF BRITAIN (AVAB). Technical Handbook: *Water Hygiene and Quality in Food and Drink Vending and Dispensing*. Cheam: AVAB. 1997.

[N2] DEPARTMENT OF HEALTH. *Choice Framework for local Policy and Procedures 01-06 – Decontamination of flexible endoscopes: Operational management*. London: Department of Health. 2013.

3 Terms and definitions

For the purposes of this British Standard, the following terms and definitions apply.

3.1 calorifier
closed cylindrical vessel in which water is indirectly heated under a pressure greater than atmosphere for the supply of hot water services, for central heating purposes and for industrial applications

NOTE The water is heated by tubular primary heaters, with hot water, steam or oil as the heating medium, or electric immersion heating elements.

[SOURCE: BS 853-1:1990+A3:2011, **2.1**, modified]

3.2 cistern
fixed, vented container for holding water at atmospheric pressure

[SOURCE: BS 8558:2015, **3.1.5**]

NOTE A cistern is commonly referred to as a "cold water storage tank".

3.3 dip sampling
process by which a sample is obtained by immersing an open, sterile container or device into a body of water

3.4 disinfection
control of microorganisms by chemical or non-chemical means

*NOTE Disinfection here relates to the outlets and systems. Disinfection is not the same as sterilization (see **3.12**).*

3.5 flow straightener
device that is inserted into a water outlet to smooth out turbulent and transitional flows

3.6 flushing
purging of water from areas of a distribution system to remove installation residues or mitigate the effects of stagnation

3.7 organism of concern
organism whose presence is not acceptable in the context of the building use

3.8 outlet fitting
device that is placed into the end of the tap faucet to control and shape the water stream and can include flow straighteners, regulators and aerators

3.9 post-flush sampling
process by which a sample is taken after an outlet or fitting has been disinfected where necessary and water has been run to waste for a prescribed length of time or until a particular endpoint has been reached (e.g. a temperature measurement), to represent the quality of the water supplied to the outlet or fitting

3.10 pre-flush sampling
process by which a sample is taken immediately after an outlet or fitting is opened, to represent water held within the outlet or fitting

NOTE This does not involve disinfection of the outlet.

3.11 sampling operative
person who has been trained and can demonstrate appropriate competence in taking samples

3.12 sterilization
complete elimination or destruction of all living microorganisms

NOTE This is not achievable in a distributed water system.

3.13 water safety plan
plan for:

a) system assessment and design;

b) operational monitoring of the control measures; and

c) management, including documentation and communication, of a) and b)

(SOURCE: WHO 2004 [1], modified)

4 Assessing water quality and developing the sampling plan

4.1 Objectives of sampling

4.1.1 Those planning a testing programme should determine the reason for sampling [see a) to c)] and take measures to ensure that the results accurately reflect the quality of the water at the time it is sampled.

a) Ad hoc sampling for verification, to provide assurance that the water being used meets the needs of its intended use, e.g. validating a new or altered control regime.

b) Sampling for investigating complaints from users relating to, for example, taint, odour, skin reaction or illness; investigating a case(s) of illness potentially associated with water use or consumption; investigating the causes of scaling, fouling or corrosion.

c) Random sampling: economically-driven or voluntary sampling used to help confirm or otherwise that water hygiene controls remain effective.

Example: Monitoring of water quality in hospitals. *Pseudomonas aeruginosa* (PA) can cause serious infection in hospital patients, particularly those who are in "augmented care units", e.g. neonatal units, critical care units, burns units, transplant units and other units determined by local risk assessment. PA positive samples from outlets are a consequence of biofilm colonization that mainly occurs at or very near the tap outlet. To determine whether PA is present at the outlet pre-flush, post-flush and representative systemic samples might be required and, as a consequence, different sampling strategies are applied.

NOTE Sampling for PA can be carried out in accordance with HTM 04-01 [2] and the SCA's The Microbiology of Drinking Water (2010) – Part 8 – The isolation and enumeration of Aeromonas and Pseudomonas aeruginosa by membrane filtration *[3] and* Examining food, water and environmental samples from healthcare environments. Microbiological Guidelines *[4]. Technologies other than membrane filters are available, such as polymerase chain reaction (PCR).*

4.1.2 Where there is a water safety plan (WSP) this should include identification of all potential hazards (see **4.3**), chemical, physical and biological. The WSP should require an ongoing sampling programme for monitoring control measures.

4.2 Sampling plan

4.2.1 A sampling plan should provide sufficient information to satisfy the data user's requirements by establishing compliance with regulations, specifications or imposed conditions, and/or identifying the cause(s) of changes in water quality. The sampling plan should be varied periodically to achieve this or to investigate out-of-specification results, for example sampling to verify or confirm the effectiveness of cleaning and disinfection following commissioning and re-commissioning of water systems, storage cisterns and/or equipment using water.

4.2.2 Sampling should be designed to take into account the time water is resident in the building, from the time it crosses the curtilage to when and where deviating quality is observed. The sampling plan should take account of such factors as:

a) residual disinfection decay;

b) the lag and exponential growth phases of bacteria within biofilms;

c) storage capacity and residence time/water age;

d) the effects of temperature; and

e) other relevant factors likely to have an effect on the water quality, e.g. condition of components, presence of lead pipework (especially in combination with other metals).

4.2.3 A responsible person should be appointed to oversee sampling at the time of construction and commissioning, as well as during the operational use of a water system. To ensure the sampling results are used effectively, the sampling plan should be prepared in accordance with BS EN ISO 5667-1 for agreement before the operations begin, taking into account any regulatory requirements or other agreed objectives. Schematic drawings should be consulted, where available, when compiling the plan.

4.2.4 Sampling points should be designated according to the sampling plan, and indicated on a schematic diagram of the water system in the sampling plan. Each outlet being sampled should be representative of the potential water quality change being investigated. The sampling plan should identify equipment that best represents the risk being investigated, e.g. equipment that constitutes a significant risk of infection because it produces an aqueous aerosol, or where there is the potential for ingress, stagnation and biofilm build-up.

4.2.5 Where it is feasible to carry out long-term periodic monitoring, the sampling plan should require sampling from both fixed and randomly selected points for each batch of samples to enable both trending of results and increased coverage of the whole system.

NOTE A single sample location might not be representative of a dynamic system where use patterns vary spatially and over time.

4.2.6 To indicate the relative risk of poor water quality from an outlet and the system, both pre-flush (see Clause **5**) and post-flush (see Clause **6**) samples should be taken. Whenever possible, samples should be collected from individual taps, rather than mixer taps, as this ensures that the samples are representative of the hot or cold system, rather than a combination of both.

4.3 Sampling task risk assessment and other considerations

4.3.1 A risk assessment should be performed and control measures put in place consistent with ensuring the health and safety of the sampling operative and others, protection of the water supply and associated asset protection.

NOTE Attention is drawn to The Health and Safety at Work etc. Act 1974 [5], the Management of Health and Safety at Work Regulations 1999 [6] and the Control of Substances Hazardous to Health Regulations 2002, as amended [7].

4.3.2 An estimate of the potential risk from each component of the system should be made based on a variety of factors, including:

a) the opportunity for microbiological colonization: uncontrolled water supply, lack of use or known contamination – the greater the complexity of the system, the greater the risk;

NOTE Practical advice regarding Legionella *is given in HSE Approved Code of Practice L8 [8] and HSG274 Part 2 [9].*

b) the suitability of conditions to sustain growth of bacteria (including legionellae), for example the use within the system of materials that do not conform to the Water Fittings Regulations [10], [11] and [12];

c) mechanisms of exposure to the sampling operative, building occupants or members of the public;

d) the susceptibility of the sampling operative and population exposed; and

e) the potential for scalding or valves breaking during sampling.

4.3.3 The effectiveness of mechanical, chemical and operational parameters of the control programme, management procedures and training should be taken into account when defining a safe system of work.

4.3.4 Employers should consider the possible increased risks to individuals who are particularly prone to legionellosis during sampling operations, due for example to underlying conditions or immunosuppression.

4.3.5 The laboratory carrying out the analysis should be consulted about:

a) selecting the correct sample containers (see **5.1.6**) and determining whether any chemical neutralizing agent is required: for safety reasons glass bottles should not be used in certain circumstances, e.g. when sampling food outlets, food production facilities, swimming pools, spa pools and hydrotherapy pools (see Annex A);

NOTE Where glass bottles are required to maintain sample integrity, the risk ought to be assessed and appropriate controls put in place.

b) any specific limitations specified within legislation, regulation, guidelines or the prescribed testing method, such as a time limit between taking the sample and testing;

c) the transport conditions required to minimize any changes in the sample;

d) the transport and delivery requirements, to ensure that samples can be analysed as close to delivery time as possible;

e) the need for any supplementary testing, e.g. for some microbiological parameters, such as *Legionella*; the temperature and/or residual disinfectant concentrations should be noted to ensure the results can be put into context for interpretation;

f) the information that needs to be obtained at the time of sampling to accompany the sample to the laboratory;

g) the methods used by the laboratory for each of the parameters requiring testing within its scope of accreditation (see also BS 8550 and "Information about this document" in the Foreword);

h) the method of transporting samples to the laboratory; and

i) any chain of evidence for investigations that might be required where legal actions could ensue.

4.4 Preparation for sampling

When the sampling operative arrives on site, they should:

a) if necessary (e.g. at a hospital), attend an induction meeting to familiarize themselves with the site and comply with any site-specific safety requirements;

b) acquire all necessary documentation and schematic drawings to understand the layout and operation of the water system;

c) determine whether there are any restrictions to taking samples, such as secondary safety and security risks;

d) review any existing WSP or sampling plan;

e) if there is no WSP or sampling plan, note this; and

f) review and update the sampling task risk assessment (see **4.3**).

4.5 Sampling following construction completion

4.5.1 General

4.5.1.1 The sampling and testing programme should be designed to verify that the quality of water delivered by a new or altered water system meets statutory/regulatory and contractual requirements.

4.5.1.2 Sampling during and following disinfection should be designed to ensure:

a) effective distribution of disinfection materials in accordance with PD 855468;

b) disinfectants have been flushed out after the allotted contact time and the system is left with a residual disinfection consistent with guidance for the maintenance of wholesome water quality; and

c) system water quality after disinfection meets the applicable requirements and client specification.

4.5.1.3 The agreed sample locations should be documented in the sampling plan which forms the basis for assessment of:

a) the effective distribution of disinfectant through the water systems at the time of initial application;

b) the concentration of disinfectant within the system after the allotted contact time, with the plan sufficient to demonstrate, with adequate samples, that there has not been excessive disinfection demand, e.g. due to the presence of biofilms or organic material which would lessen the effectiveness of the disinfectant process; and

c) post-flush and disinfection verification samples, for example:

- total viable counts (TVC), sometimes known as heterotrophic plate counts, measured at 22 °C;
- TVC measured at 37 °C;
- *Coliform* bacteria;
- enterococci;
- *E. coli;*
- *Legionella*;
- *Pseudomonas aeruginosa*; and
- any other water quality parameter.

4.5.2 Construction completion

4.5.2.1 Samples should be:

a) appropriate for the specified purpose, i.e. microbiological assessment, chemical analysis or on-site testing;

b) sufficient in number to be fully representative of the distribution system, sub-branches, tanks, cisterns and hot water storage vessels, as well as the condition to be evaluated, e.g. completion of a cleaning process, efficacy of distribution of disinfectant; and

c) 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.

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

4.5.2.2 The microbiological tests should be carried out and the results provided at handover to demonstrate that the system is clear of organisms of concern, such as those listed in **4.5.1.3**c).

NOTE There is a number of generalized methods for obtaining counts for Pseudomonas*, e.g. BS EN ISO 16266 for the enumeration of presumptive* Pseudomonas *in meat and meat products, but these need to be interpreted on a method-specific basis.*

4.5.2.3 Where Coliform or other organisms of concern are present, the sampling point should be flushed and retested, using pre-and post-flush samples to determine the location of the microbial contamination. If positive results persist, investigation into the cause should be extended with a view to repeating the disinfection process on the distribution system.

4.6 Re-sampling before occupancy

4.6.1 When required, sampling for microbiological quality (including *Legionella*) should be carried out following mothballing, refurbishment, etc., and in advance of occupation (see PD 844568).

4.6.2 Where the system has been disinfected in accordance with PD 855468, sampling for disinfection residues and microbiological water quality should be carried out to ensure that the water quality is suitable for its intended use.

4.6.3 The sampling plan should include samples from the incoming mains water (as close to the building inlet as possible), cisterns, hot water storage vessels and outlets as indicated in the risk assessment.

NOTE Good practice in an unoccupied building is for these not to be filled until the building is occupied, i.e. bypassed so that only mains is used until there is the need for stored water.

4.7 Lifecycle monitoring

NOTE Microbiological sampling during occupancy can demonstrate the efficacy of supplementary disinfection, based on a programme of regular evaluation at sentinel taps.

The samples should be collected together with other information to evaluate the efficacy of water quality management at the monitoring point.

4.8 Operational monitoring and sampling

NOTE This stage of system monitoring is often referred to as "routine monitoring".

4.8.1 For routine monitoring purposes, the representative sampling points identified in the sampling plan (see **4.2.4**) should be used.

4.8.2 Because the risk of deterioration in water quality varies over time the monitoring should be designed to indicate whether that risk is rising or falling. Monitoring should cover a range of material factors, for example those giving rise to:

a) factors that increase risk:

   1) as water gets warmer during the summer months the risk of microbiological growth increases, particularly in supply water, storage tanks and poorly insulated pipes;

   2) extended holidays or shut-down periods result in less water use in the building, causing a longer residence time and opportunity for microbiological growth;

   3) change of use of a building or part of a building; and

b) factors that reduce risk:

   1) removal of a dead leg reduces the risk of a stagnant zone of water and localized microbiological growth that can seed the system;

   2) system flushing and chlorination to remove biofilm accumulation.

*NOTE Guidance on appropriate statistical tools for evaluating the data acquired as a result of monitoring water is given in Annex B (see also Clause **7**).*

4.8.3 Operational monitoring should inform the implementation and maintenance of the WSP or written scheme for the building or estate, and provide confidence that:

a) the plan is robust and water is of satisfactory quality in both normal and abnormal operating conditions;

b) where improvements in management are needed, the WSP is reviewed;

c) the design and operation of any water storage system is preserving water quality; and

d) remedial actions or alternative sources of supply can be implemented when required.

4.9 Sampling during incident investigations

4.9.1 The planning of sampling for incident investigation should only be undertaken by competent and experienced people with a detailed knowledge of the building and any plant that is implicated in the water quality deviation.

4.9.2 The sampling plan design should ensure that changes in water quality can be identified at any and all critical points from where the water enters the building to the outlets.

NOTE Such sampling might need to be more intense than that conducted for routine monitoring, involving the collection of more samples.

4.9.3 Depending on the nature of the incident under investigation there is likely to be a range of organisms and system-specific water quality criteria to be assessed, so the precise sampling needs should be assessed and documented in the sampling plan.

NOTE Specialist techniques might be required for the assessment of the cleanliness of the outside of a tap in a hospital intensive care unit, or for Legionella *sampling of a showerhead (see BS 7592).*

4.10 Common sampling points

4.10.1 Drinking fountains and vending machines

An investigation of the water supply to a vending machine or in-situ water chiller and its influence on the water quality it delivers should be conducted in accordance with the Automatic Vending Association (AVA) *Water Hygiene and Quality in Food and Drink Vending and Dispensing* [N1].

NOTE 1 Drinking fountains that are directly connected to the mains cold water supply may be treated as cold taps, but a dynamic reappraisal of the sampling location might be needed to ensure correct equipment and techniques are applied.

NOTE 2 The need to sample drinking water provided though refrigerated and/or filtered dispensers depends on the objectives and scope of sampling. Outlet quality is often tested for Coliforms and E. coli *transferred by human contact, while TVC counts are compared with supply counts to identify significant change.*

4.10.2 Water supply points with removable hoses and devices

Any pre-flush sample should be taken directly through the outlet in accordance with Clause **5**, after which the outlet should be disconnected and cleaned. The orifice should also be sampled. The outlet should then be reconnected to the hose/device, and another sample taken if verification of the clean is required.

4.10.3 Domestic hot and cold water outlets

NOTE 1 Sink and basin taps provide the majority of sample locations for hot and cold water services in typical buildings

Where a risk assessment for Legionnaires' disease indicates that there is a need to sample for *Legionella* bacteria, samples should be collected from locations indicated by the risk assessor.

NOTE 2 Additional samples may be collected from outlets of particular concern showing discolouration or other concerns.

NOTE 3 Outlets regularly used for routine monitoring include "sentinel taps". These are chosen to be representative of the system condition. In a simple cold water system, the sentinel points are typically the tap furthest (far sentinel) and the tap nearest (near sentinel) to the supply or storage tank (see HSG274 Part 2 [9]).

4.10.4 Cold water cisterns and hot water storage vessels

4.10.4.1 Stringent precautions should be taken when sampling water inside a cistern, to prevent contamination. Sterile dip samplers should be used.

4.10.4.2 The quality of water entering a cistern or hot water storage vessel should be determined by post-flush sampling either the last outlet or the dedicated sampling point before the inlet valve. The quality of water in a cistern or hot water storage vessel should be determined by post-flush sampling the first outlet after the cistern or vessel.

4.10.4.3 Drain points should not be used to determine the outlet quality for cistern or hot water vessel sampling as stagnant regions in the base of the cistern or hot water storage vessel are not representative of the supplied water.

NOTE Sampling these points could be useful for investigative purposes.

4.10.5 Storage calorifier drain-off point

4.10.5.1 Storage calorifier drain-off points should only be sampled if specifically indicated by the sampling plan, and where it is safe to do so.

NOTE A visual clarity check is required by HSG274 Part 2 [9].

4.10.5.2 When taking microbiological samples, the outside and inside surfaces of the outlet side of the drain valve should be disinfected. Any pipework connected to the drain should be removed, if possible, before disinfecting the valve. The drain valve should then be opened for a few seconds in order to rinse out any remaining disinfectant from the valve. If there is insufficient space to place a sample container under the outlet to collect the sample, then clean, sterile silicone rubber tubing can be attached to the drain valve. The visual appearance of the water, for example the presence of rust deposits, sediment or corrosion products, should be noted in order to facilitate the assessment of the cleanliness of the calorifier.

4.10.6 Water closet cisterns

Water closet cisterns (flush toilets) should only be sampled as part of an investigation or if a risk assessment indicates that this is necessary. Sampling should be carried out in accordance with **6.4.5**.

4.10.7 Showers and thermostatically-controlled outlets

4.10.7.1 Samples from mixer taps are not likely to be representative of the whole system or of hot or cold water quality. Showers or thermostatic mixing valve (TMV) outlets with mixers should not be used as sentinel outlets, but might be the most likely to develop localized problems, so pre-flush outlet sampling can be informative.

NOTE It is difficult to prevent legionellae growing downstream of TMVs that are set to control temperatures below 45 °C and are not well used and maintained.

4.10.7.2 Pre-flush sampling of showerheads is a useful indicator of conditions and should be conducted when indicated in a risk assessment or specified in a sample plan, or to determine whether control measures are effective.

NOTE A quality-assured system of shower disinfections and temperature checks is not able to detect localized user-induced stagnation or deterioration of components giving rise to localized problems.

4.10.8 Dedicated sampling points not intended for use by building occupants (see Annex C)

4.10.8.1 Dedicated sampling points should be installed without creating a dead leg.

4.10.8.2 The outlet of the sample valve should be loosely plugged when not in use to avoid accidental discharge and the ingress of external contamination.

Example 1: Water softeners: the sampling operative should have access to the feed water and the softened water before any other plant, and the sampling points should be suitable for sampling for non-microbiological and microbiological purposes.

NOTE Reasons for investigating softeners include:

- *evaluation of microbiological burden (growth on media bed);*
- *evaluation of softening performance; and*
- *assessing the efficiency of valves during brine regeneration cycles to ensure that chloride backwash does not enter the outlet stream.*

Example 2: Carbon filters for removing disinfection residuals: where activated carbon treatments are applied for the necessary depletion of chlorine, chloramine or chlorine dioxide, for example before treatment of water by reverse osmosis, dedicated sampling points should be available to check the efficacy of the carbon bed in order to assess the need for replacement/ regeneration or amendment of contact time through the bed. Such sampling points might also be required for microbiological samples.

4.10.9 Special (medical) devices

Sampling of special (medical) devices should be conducted in accordance with the applicable part of BS 15883 and CFPP 01-06 [N2].

4.10.10 Expansion vessels

Where it is suspected that an expansion vessel holding water above 20 °C is harbouring bacteria, the supply valve should be closed and a sample taken from an appropriate outlet representative of the water in the vessel.

4.10.11 Point-of-use (POU)/instantaneous heaters (see 5.5)

NOTE 1 Low volume POU water heaters (<15 L storage) or instantaneous water heaters are usually employed to avoid the need for larger centrally-heated systems. They are often supplied with direct mains-fed or boosted cold water. Such systems generally heat water to a point dependent upon a manually-adjusted setting. Low volume systems normally deliver a small volume of stored hot water, after which time they need to recover back to the set temperature. Instantaneous systems generate hot water as they are used.

A point-of-use/instantaneous heater should only be sampled where the need for this is indicated by the risk assessment or investigation of a complaint.

NOTE 2 Samples may be pre-flush or post-flush, though post-flush samples are likely to have reduced temperatures due to the limited water volume present. Post-flush samples are therefore more likely to demonstrate the water quality of the cold water supplied to the water heater, and this type of sampling might be more relevant for water heaters which have limited use and whose supply line might be stagnant.

4.10.12 Incoming supply

Sampling of water entering the building should be included in the scope of any routine sampling or investigation of water quality issues within the building. The results should form the baseline against which results obtained elsewhere in the building can be compared. The sample should be obtained from the first available cold water outlet on the incoming supply, which may be a sink or basin tap or a dedicated sampling point provided for the purpose.

4.11 Sample parameters

4.11.1 Non-microbiological parameters

4.11.1.1 General

The method of sampling and analysis should be appropriate to the purpose of the monitoring, for example, the correct type of sample container and preservation techniques can significantly affect results, and the selection identified in the sample plan should be strictly adhered to.

NOTE There is a range of parameters that might be relevant, some of which can be carried out on site, while others are best carried out in a laboratory.

4.11.1.2 Construction completion

4.11.1.2.1 During the disinfection process the following tests should be conducted:

a) field tests for verification of chlorine or other disinfectant concentration achieved throughout the system;

b) field tests for pH to verify that any correction to ensure effective levels of free chlorine has been achieved; and

c) field test for electrical conductivity or total dissolved solids, to verify that the disinfection agent and dissolved salts have been flushed from the system following disinfection.

4.11.1.2.2 Detailed sampling records should be made, signed and handed over to supervising parties as evidence that the required works have been completed.

NOTE A single statement of certification without supporting detail is not regarded as an adequate demonstration of the uniformity of flushing of a system.

4.11.1.3 Operational monitoring

*NOTE 1 Chemical testing in this context is commonly a mixture of field tests and laboratory analysis. For information on the range and applicability of the tests to be deployed, see **6.4**.*

Where online disinfection is used, non-microbiological sampling should be carried out at the same time as microbiological sampling, for example:

a) the measurement of disinfection residuals at the same time as the collection of microbiological samples; and

b) the measurement of pH at the same time as chlorine residuals in order to evaluate likely disinfection potency relative to guidance provided in PD 855468 and CIBSE TM13 [13].

NOTE 2 Other examples of non-microbiological testing include:

- *measurement of hardness and scale forming parameters;*
- *measurement of output water quality from softeners, to control blending and detect faults;*

- *measurement of iron, zinc and copper to detect corrosion issues in storage vessels and pipework; and*
- *measurement of lead where there are known or suspected lead pipes.*

See Guidance on the implementation of the Water Supply (Water Quality) Regulations 2002 (as amended) in England *[14],* ***11.1****.*

4.11.1.4 Incident investigation

When investigating breaches of water quality requirements the need for coincidental field testing of key parameters should be taken into account in conjunction with any laboratory evaluation of the same samples and sample locations.

NOTE This can be of importance when interpreting the results since it allows as much information as possible to be assessed in a multivariate evaluation approach.

4.11.2 Microbiological parameters

4.11.2.1 The microbiological monitoring regime should be able to demonstrate that the organisms of interest or microbial indicators are not present, or likely to be present, in numbers contrary to any use-specific guidance. Any changes observed in the microbiological quality of water might not therefore be relevant to the point of supply at the building curtilage. For example, the absence of a particular organism in water supplied to the building and its appearance in samples within a distribution system should be regarded as a significant change.

4.11.2.2 Similarly, a significant increase in indicator organisms in samples taken within buildings should be regarded as a warning that water quality is deteriorating and that cohabiting opportunistic pathogens, such as *Legionella*, could also be supported in the system. Such changes should trigger exploration of the cause.

NOTE For example, a significant increase in TVC counts could indicate failing disinfection efficacy and/or the establishment of biofilms, which could, in turn, lead to the colonization/regrowth of other, previously supressed organisms.

5 Outlet (Pre-flush) sampling techniques

5.1 General

5.1.1 In order to determine the conditions of a particular outlet, a pre-flush sample should be collected.

NOTE This is the type of sample that is most representative of the risk to individuals.

5.1.2 A pre-flush sample should be taken in accordance with BS 7592:2008, **8.4**.

5.1.3 If a risk assessment indicates that the location is likely to have a significant *Legionella* burden or an outbreak is being investigated, precautions should be taken to avoid causing an aerosol.

5.1.4 The pre-flush sample should, ideally, be taken when the outlet has not been used for a period of time (for example, up to several hours). The sample should be collected without disinfection of the outlet. The top of the sample bottle should be removed, taking care to avoid touching the rim of the bottle or contaminating the surfaces of the sample bottle cap which will be in contact with the sample of water. The water sample should be collected immediately after the outlet is turned on without letting any water run to waste.

5.1.5 The sample container should be filled as required for the parameter being determined. For example, when sampling for microbiological testing, the bottle

should be filled almost to the top, leaving a small air gap, but when sampling for some chemical parameters, the bottle should be completely filled, with no air gap. Care should be taken to avoid flushing any biocide-neutralizing agent or other stabilizing additive out of the container (see **6.4.5.1.5**). The container should then be capped and the contents agitated till the biocide-neutralizing agent is well mixed within the water. The container should be sealed for submission to the laboratory for analysis.

5.1.6 Separate containers should be used for bacteriological, physical and chemical determinations (see Annex D).

5.1.7 The temperature of the water at the outlet should be taken after the sample has been collected.

5.2 Manual mixing taps

The sample should be taken immediately with the control set to deliver a mix of hot and cold water.

5.3 Thermostatic mixing taps and hot taps fed from thermostatic mixing valves

NOTE 1 A thermostatic mixing tap is a combination tap in which hot and cold water are mixed either within the body of the tap or at the point of discharge.

For taps in which the hot and cold water are mixed within the body of the tap, or just before the tap, including TMVs, pre-flush samples should be taken with the setting at the normal use temperature (usually in the range 38 °C to 46 °C) for thermostatic taps. Temperature measurements should be recorded after sampling.

NOTE 2 With fail-safe TMVs, it is impossible to obtain a sample comprising solely hot water, as some cold water is always released first. Hot water feeding the mixer is usually held at a temperature greater than 43 °C, which results in a blend of hot water with cold water.

5.4 Showers

When collecting a sample for a shower with a variable mixture of hot and cold water, the shower should be set to its coldest setting and the settings rapidly increased to the maximum allowable temperature. When sampling a shower with a fixed head, a new food-grade plastic bag should be secured (using an elastic band) around the shower head to minimize exposure to aerosols and ensure as much as possible of the water in the fitting is sampled. One corner of the plastic bag should then be cut off with clean scissors that have been sterilized or disinfected using the methods in **6.3** (see BS 7592). The opened corner of the bag should then be placed into the mouth of the sample container. The sample should then be collected.

NOTE Microbiological risk imposed by fouling of the hose and shower head is assumed to be negated by regular cleaning regimes. The protocol in Annex E is designed to assess the fouling impact on pipework supplying the TMV and the influence of the valve itself on water supplied to the user of the shower facility.

5.5 Sampling from point-of-use (POU) water heaters

NOTE If associated temperature measurement is required and the hot water from a low volume heater is likely to be exhausted before a minute has elapsed, it is acceptable to record the maximum temperature achieved within a minute of flushing the outlet.

Both the maximum temperature and the time elapsed to achieve this temperature should be recorded.

5.6 Biofilm samples

NOTE Biofilm samples can be collected with sterile absorbent cotton wool swabs.

5.6.1 If the surface being sampled is not wet, the swab should be moistened with Pages' saline or dilute (1:4) Ringer's solution. Holding the swab with tweezers if necessary, the surface to be sampled should be wiped whilst rotating the swab so that the whole surface of the swab is used. The swab should then be transferred to a tube, which should then be sealed for transport to the laboratory. Alternatively, the swab should be snapped off into a small, known volume of sterile Pages' saline or dilute (1:4) Ringer's solution contained in a sterile plastic, screw-capped container (usually supplied by the laboratory carrying out the analysis). Thicker layers of biofilm should be scraped off with a sterile scraper and placed into tubes, which should then be sealed for transport.

5.6.2 When sampling a water closet cistern or water storage cistern, the biofilm should be collected at the interface between the water and atmosphere, or a small amount of water may be drained from the cistern and the sample collected from just below the normal water-line mark. Maximum growth of biofilms usually occurs at the water-air interface around the normal fill line. To facilitate quantification of legionellae, a sterile template should be used so that a known surface area is sampled.

5.6.3 In the case of showerheads and pipes, if accessible, biofilms can also be sampled from their inside surfaces by means of a swab. The entire surface should be swabbed to maximize repeatability. Samples should then be labelled "Entire shower head", etc.

NOTE Further guidance is given in Examining food, water and environmental samples from healthcare environments. Microbiological Guidelines *[4].*

6 Systemic post-flush sampling methodology

6.1 General

NOTE Post-flush samples are taken to assess the systemic water quality in the branch serving the outlet.

6.1.1 Where a pre-flush sample is required (see Clause **5**), this should be collected before samples are taken of any other part of the system. If temperature measurement is required, it should be taken at this time.

6.1.2 Post-flush samples should not be collected from showers, as it is almost impossible to ensure that the shower head, hose and mixer components have been adequately disinfected.

6.1.3 Post-flush samples should not be taken from taps with mixers, as there is the possibility of hot water contaminating the cold water supply, or vice versa.

6.2 Preparation of outlets for post-flush microbiological sampling

6.2.1 If a pre-flush sample has not been taken, the outlet should be flushed before the post-flush sample is taken. Any outlet fittings should be removed, and the outlet cleaned externally and disinfected in accordance with **6.3**.

6.2.2 The outside of the sample point should be sprayed with a suitable disinfectant solution. Disinfectant solution (see **6.3**) should be sprayed inside the sample point and left for 60 s. The sample point should be opened for 60 s and the post-flush sample taken. The disinfectant should then be rinsed from the outside of the tap to avoid corrosion.

6.3 Disinfection of outlets

6.3.1 A non-microbiological sample should be taken before disinfection.

6.3.2 Chemical disinfection should be the preferred method for routine monitoring, as flaming can create additional hazards and risks and can damage some tap finishes and components. Any outlet fittings should be removed, e.g. spray inserts and flow directors, all accessible parts of the tap cleaned and the outside of the tap swabbed with disinfectant solution. Whilst wearing protective goggles, the bottle should be washed using a flexible plastic Pasteur pipette or other appropriate means to inject disinfectant inside the nozzle of the tap until it runs out. 60 s should be allowed for the disinfection process to take place.

6.3.3 The outlet and surroundings should then be rinsed with clear water to avoid damage to the aesthetic finish of the outlet and surrounding surfaces, and any hoses, nozzles or secondary fittings removed before:

a) the outside of the outlet is sprayed with a suitable chlorine disinfectant or isopropanol solution (see Annex F for a process for preparing a suitable disinfectant solution); and

b) the disinfectant solution is sprayed inside the outlet and left for 60 s before being flushed out; and

c) the disinfectant is rinsed from the outside of the outlet and surrounding areas after the sample has been taken.

6.4 Preparation of sample points for post-flush non-microbiological sampling

6.4.1 Methodology

6.4.1.1 Chemical sampling should be carried out in accordance with the procedure given in Figure 1.

6.4.1.2 If a non-microbiological pre-flush sample is requested, this should be taken before flushing the outlet and before any other sample is taken. The bottle should be filled with the first draw from the tap. The bottle should not be rinsed.

6.4.1.3 The outlet should be flushed for the applicable duration given in Figure 1, or longer if the tap is suspected to be on a long dead leg.

NOTE In this case a site thermometer can be held in the flow of the tap until the temperature stabilizes. This ensures that water left lying in the supply pipe is flushed to waste and all subsequent tests are conducted on representative samples of water.

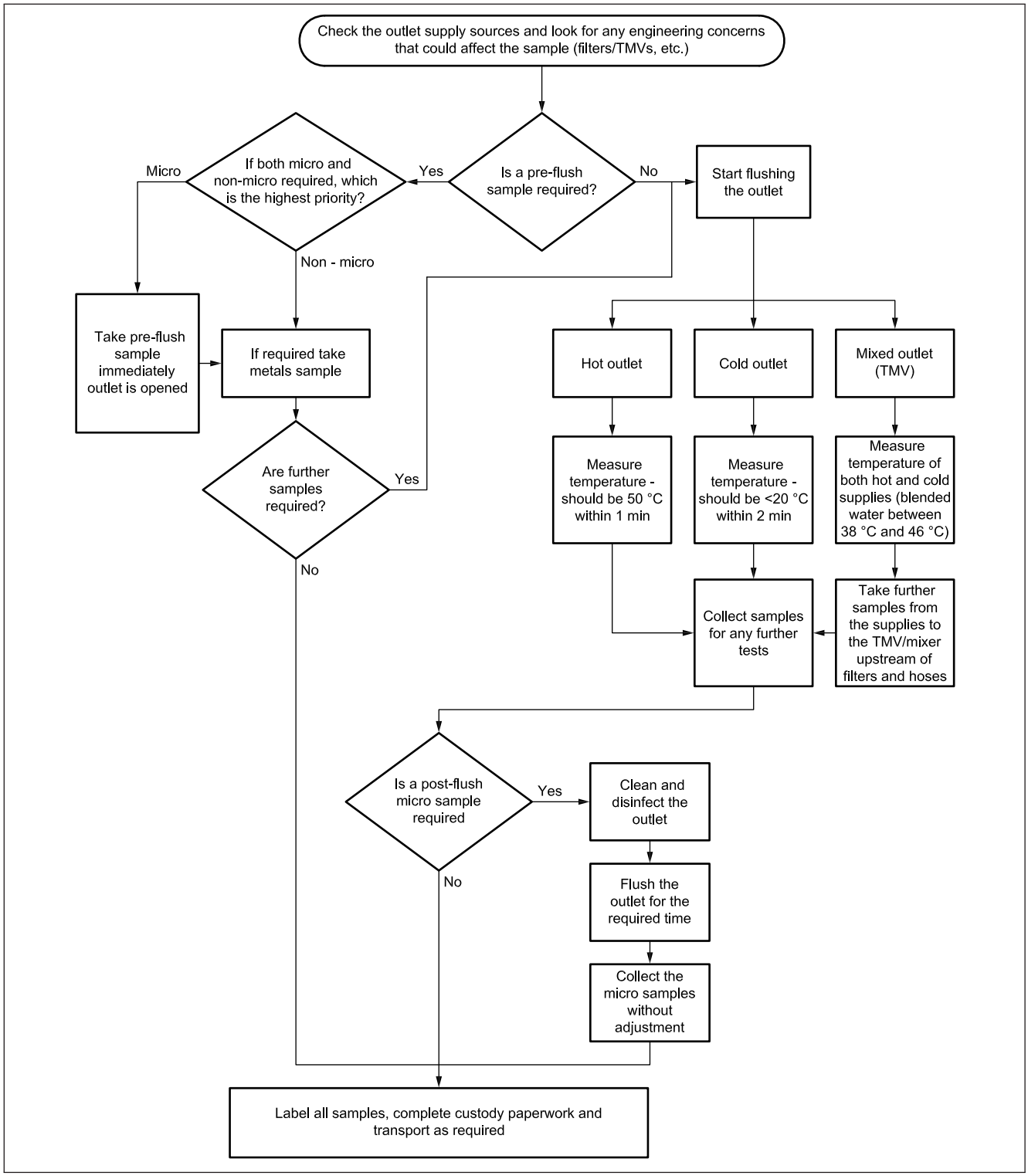
6.4.2 Free and total chlorine analysis

6.4.2.1 If free and total chlorine analysis is required at any sample point, the test should be performed on site after flushing the tap and before disinfection.

6.4.2.2 The sample for chlorine residuals should be taken straight from the tap into the test equipment. Protective disposable gloves and eye protection should be worn when using kits incorporating diethyl-p-phenylene diamine (DPD) powder to carry out the chlorine test.

NOTE Not all water supplies are chlorinated. Incoming supplies might be chloraminated. Other disinfection techniques might be required. Also, additional treatment might be applied in the building, e.g. chlorine dioxide and copper/silver.

Figure 1 **Sampling of water from cold and hot water outlets for purpose of investigation or monitoring**



6.4.3 Sampling techniques for outlets

Outlets should be sampled in accordance with the procedure given in Figure 1.

The sampling operative should:

a) not hold the bottle by the neck;

b) not flush out the sample bottle before taking the sample;

c) use a sample bottle in accordance with Table D.1 and Table D.2, as indicated by markings on the bottle;

d) ensure that the bottle is within its expiry date;

e) not lay the bottle or bottle cap down, as this might cause contamination of samples;

f) observe good personal hygiene;

g) reduce the flow if necessary to achieve an even flow before sampling;

h) remove the cap from the bottle at the last opportunity and not lay the cap down;

i) hold the cap firmly between the fingers of one hand with the open end down;

j) not allow the fingers to touch the inner surface of the cap and not turn the cap over;

k) without changing the water flow, place the bottle in the stream of water from the tap and fill to the base of the neck (without allowing the bottle to overflow), leaving where necessary a small air gap at the top to allow mixing in the laboratory (except when sampling for a parameter requiring the bottle to be completely full) (see Annex D);

l) carefully replace the cap and turn off the tap;

m) label the bottle(s) adequately with the appropriate label(s);

n) ensure the chlorine disinfection or isopropanol solution bottle is free of drips and tightly sealed, and store well away from all sample bottles; and

o) put the bottle upright in a container (transport at temperatures defined in Table D.1 and Table D.2) and deliver to the laboratory as soon as possible.

NOTE Further guidance is given in Examining food, water and environmental samples from healthcare environments. Microbiological Guidelines *[4].*

6.4.4 Temperature measurement (hot and cold systems)

6.4.4.1 The water temperature should be measured routinely (see HSG274 Part 2 [9]), as part of a risk management process (for example, to determine parts of a hot water system that are cooler than the remaining parts and therefore more prone to colonization by legionellae) and to assist in selecting the outlets from which samples should be taken, e.g. those posing the highest risk because of poor temperature control.

6.4.4.2 If a pre-flush sample is required for analysis, this sample should be taken before temperature measurement is undertaken.

6.4.4.3 If the temperature of the pre-flush sample is required to be recorded, it should be measured at this point and the compliance temperature measurement in **6.4.4.4** should be carried out as a separate process.

6.4.4.4 For measuring water temperature at an outlet to assist in interpretation of the test results, the thermometer should be placed directly in the water flow at the conclusion of the pre-flush sample.

6.4.5 Dip sample techniques

6.4.5.1 General

6.4.5.1.1 Appropriate precautions should be taken to prevent cross-contamination occurring between sampling sites and samples. Only sampling operatives trained in aseptic technique should take dip samples. The lid of the cistern should be cleaned and disinfected to avoid any potential contamination falling in (see Annex F). A new pair of disposable gloves should be worn for each sample and a sterile dip sampler should be used to remove water from the cistern. The sample should be decanted into a sterile sample bottle with neutralizing agent, taking care not to contaminate the dip sampler.

NOTE A sterile dip sampler of appropriate size may be used for all sites, and the water poured into the sample bottle. Sterile, individually-packed, plastic disposable dip samplers, with handles that can be snapped off after use, are available but are usually too small to collect a sufficient volume of sample in a single action. Alternatively, a freshly cleaned and disinfected metal (for example, stainless-steel) vessel of appropriate size, with a chain or handle attached that can be disinfected, may be used for non-wholesome sites.

6.4.5.1.2 To prevent cross-contamination from one sample to another, the sampling device should be thoroughly disinfected between each sampling occasion with a disinfectant wipe (see Annex F) (unless the bottles have been individually packed), or a fresh device sterilized by autoclaving should be used. If the device is disinfected using chlorine-based reagents, care should be taken to prevent disinfectant entering the water being sampled.

NOTE Commercially available sterilized disposable dip samplers, i.e. dip samplers that are used only once and are mounted onto short rod handles, might be suitable for use when taking dip samples from small cisterns.

6.4.5.1.3 If a non-wholesome sample is to be collected by immersing the sample bottle in the water, a new pair of disposable gloves should be used for each occasion that a sample is collected.

NOTE It is not appropriate to use ethanol or propan-2-ol to disinfect the outside of bottles used to dip-sample drinking water cisterns.

6.4.5.1.4 The stopper or cap should be removed with the gloved hand, ensuring nothing touches the inside of the bottle or cap.

6.4.5.1.5 Care should be taken to avoid any biocide neutralizing agent or other stabilizing additive contained in the sample bottle (see Annex D) being lost when the sample bottle is opened and immersed in the water to collect the sample. While the bottle is being plunged into the water, the long axis should be kept approximately horizontal, with the neck pointing slightly upwards to avoid loss of the neutralizing agent. The bottle should be quickly immersed to between 200 mm and 400 mm below the water surface, at which point it should be tilted upwards to allow it to fill, and withdrawn as soon as the bottle is almost full. A small air gap should remain when the bottle is capped (except when sampling for a parameter requiring the bottle to be completely full). The bottle should be tightly sealed and shaken to ensure any biocide neutralizing agent present is well mixed in the water sample.

6.4.5.1.6 If the water being sampled is managed with non-oxidizing biocides, the laboratory should be consulted for the appropriate sample handling and preservation techniques when sampling for microbiological purposes.

6.4.5.2 Non-biological dip samples

Containers for non-biological determinations need not be internally sterile, but the sampling apparatus should be cleaned and disinfected before being dipped into cisterns (see **6.5.3** for containers).

6.5 Sample storage and transport

6.5.1 Because storing hot samples next to cold samples inevitably warms the cold samples, negating the cooling effect of the cold box/bag, and the process of taking the hot sample from the system itself starts the cooling process, only cold samples should be placed in the cool box/bag, or separate cool boxes/bags should be used.

6.5.2 The laboratory should be consulted about storage and transport but, if no advice is given, the provisions of BS EN ISO 5667-3 should be followed.

6.5.3 The following steps should be taken.

a) Fill sample containers in accordance with Annex D.

b) Include the time of sampling and the storage conditions (including temperature) in the sample information (see Annex D).

c) Store filled sample containers in accordance with Annex D.

d) Refrigerate samples in accordance with Annex D.

e) Keep *Legionella* samples in a separate bottle from other water samples that are taken for testing. Non-microbiological and microbiological samples should be stored in separate (appropriate) bottles.

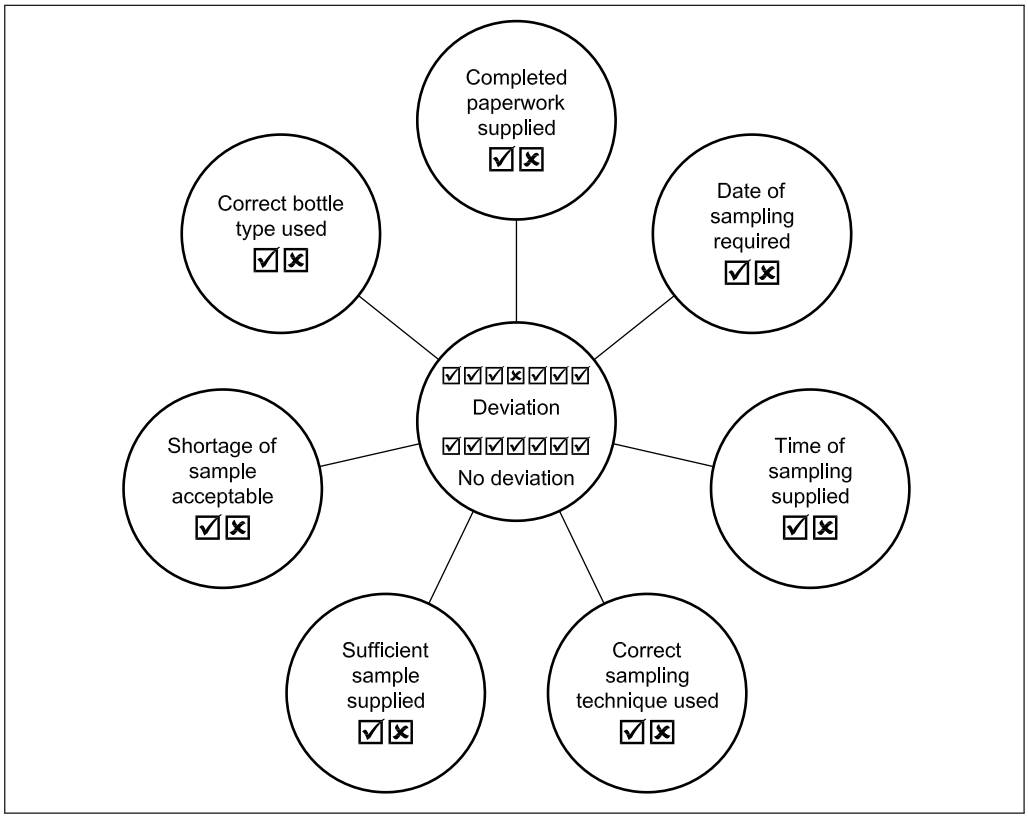
f) Store hot and cold samples separately to avoid unnecessary heating of cold water samples which can distort microbiological evaluation.

g) Transport samples to the laboratory or to a suitable (refrigerated where necessary) store for collection in accordance with Annex D.

h) Transfer samples stored in cool bags/boxes during transport to thermostatically-controlled storage (fridges) at the laboratory or laboratory drop-off points at the earliest opportunity.

NOTE BS EN ISO/IEC 17025 requires the laboratory to report any deviations from the handling and documentation requirements. Figure 2 illustrates how to avoid such deviations. Annex G gives examples of the kinds of documents to be maintained to demonstrate that each sample has been correctly taken, put in the correct bottle at the correct temperature, and properly stored and transported. The investigation records for the building need to indicate that anything identified by the laboratory is used in the interpretation of the information.

Figure 2 **Avoiding deviations from handling and documentation requirements**



7 Information to assist interpretation of results

7.1 General

7.1.1 When interpreting the results, reference should be made to the sampling plan.

NOTE 1 The interpretation of results requires that sufficient detail is obtained at the time of sampling. In some cases, such as sampling for Legionella*, additional test parameters, such as the temperature and biocide levels at the time of sampling, might be required (see L8 [8], HSG274 Part 2 [9] and HTM 04-01 [2]). Appropriate statistical considerations are detailed in Annex B.*

NOTE 2 When a sample of water is taken for analysis, irrespective of the volume sampled and tested, the results only reflect the quality of the sampled water and not the whole body of water. Individual sample results do not reflect the whole system and might be difficult to interpret, particularly microbiological samples where contamination could be intermittent. Regular sampling from predefined sample points combined with random sampling gives a better indication of microbiological risk and, when carried out for trend analysis, also indicates deviations from the norm and, possibly, a failure in disinfection or a post-disinfection contamination event.

NOTE 3 Examination of data allows managers to adjust their interpretation of the building's performance and to assess any trends that contribute to changes in identified risks.

NOTE 4 There are limitations in the conclusions that can be drawn from any single sample. Multiple samples might be required to give confidence in the interpretation of the condition of the system (i.e. the indication that action is required), e.g. the baseline noise, background condition. Baseline noise, in this context, is the random variability (combination of the sampling variability and the variability of parameter occurrence).

NOTE 5 The use of such techniques allows data users to respond to changes that give early warning of critical conditions developing, rather than reacting to information that requires urgent action.

7.1.2 When monitoring sentinel outlets, the time of sampling should reflect the conditions following the longest period of system stagnation to highlight the greatest risk of water quality impairment.

NOTE Such an approach ensures that latent risks are not masked by a monitoring regime which only returns favourable results because sampling occurs at periods of high water throughput.

7.2 Non-microbiological parameters

An accurate record of any relevant conditions, e.g. temperature or water turnover, should be made at the time of sampling to provide the information needed to permit assessment of the overall impact of the building's use and function on the quality of water.

7.3 Microbiological parameters

Samples should be collected coincidently with on-site tests for disinfection residuals to ensure that the water management regime efficacy can be interpreted with the greatest degree of confidence.

8 Documentation and reporting of results

8.1 General

In addition to information relating to the sample itself (see **4.11**), the following supplementary information should also be reported in order to assist those interpreting the laboratory and field test results, particularly if the samples relate to the management of water features or other processes requiring treatment:

a) a list of biocides in use;

b) the dosing regime, including date and time of last dose; and

c) details of water softener performance checks.

NOTE Providing copies of statutory safety information for the treatment of chemicals with the report can aid interpretation.

8.2 On-site use of test kits

NOTE On-site methods exist for many physical and chemical, and some microbiological, analyses of interest in assessing water quality. The level of accuracy, sensitivity and specificity attainable depends on the details of the method, the circumstances under which it is carried out, and the training and experience of the person carrying it out. In some cases the potential loss of accuracy relative to a laboratory method is offset by carrying out the analysis before any significant change in the sample characteristics can take place.

8.2.1 An appropriate test kit should be identified as part of the planning process. The sampling process and record keeping for on-site methods should be as rigorous as that for samples destined for the laboratory.

8.2.2 The test kit reagents should be within the manufacturer's use-by date. Each test kit should be used in accordance with the manufacturer's instructions.

NOTE Guidance on test kits in water analysis, including use of reference standards, is given in BS 1427 and BS ISO 17381. Anyone using a colorimetric kit needs to ensure that any colour blindness does not prevent the correct use of the test kit.

8.2.3 The lower limit of detection for any test kit used should be not greater than 10% of the concentration of interest, e.g. chlorine test kits should have a limit of detection of not greater than 0.01 mg/L when the concentration of interest is 0.1 mg/L.

8.3 Laboratory analysis

8.3.1 For microbiological tests carried out to a particular standard, the laboratory should be requested to report the mathematical limit of detection for the assay in their report, i.e. for microbiological assessments this is not the same as the detection limits.

NOTE The detection limit can be affected in part by the size of the sample taken, and the volume requested by the laboratory varies depending on the parameter being evaluated. For example, for the culture of Legionella *or the determination of low concentrations of lead, the sample is concentrated and the concentrate is tested. In such cases, the larger the sample, the greater the factor of concentration which can be used and the lower the limit of detection (i.e. the more sensitive the test).*

For example, in Legionella *enumeration, a 1 000 mL sample is commonly filtered and recovered into 10 mL diluent, of which 0.5 mL is plated onto agar. Therefore, if one colony is detected on the agar plate then this equates to 20 colonies per 1 000 mL. However, if only 500 mL are filtered, perhaps because the sample is turbid, the detection limits go up to 40 (40 cfu/L). If 200 mL are filtered then the dilution factor goes up to 100 (100 cfu/L).*

8.3.2 Laboratory reports should express results as indicated in the particular standard to which they are working.

8.3.3 Where a laboratory processes less than the sample volume submitted, the report should state the volume filtered and how that affects the theoretical detection limit.

8.3.4 Where the result is below the detection limit of the method, the report should state the detection limit.

8.4 Sample documentation

8.4.1 General

8.4.2 A water analysis is of limited value if it is unaccompanied by detailed information about the sample, so the source of the sample and the conditions under which it was collected should be recorded and a suitable record attached to the bottle immediately after filling.

8.4.3 The results of any on-site analyses carried out should also be included in a report with the sample. Labels and forms should be completed at the time of sample collection. The sampling operative should never move on to another task before completing all documentation at a site.

NOTE Some laboratories are using only electronic systems with direct input into lab systems.

8.4.4 The information given in the sampling report depends on the parameter under investigation but, for microbiological analysis, should include at the least the following:

a) location and name of sampling site, with coordinates and any other relevant locational information to enable identification on a subsequent visit;

b) details of sampling point, e.g. tap/shower head, including type of sample (e.g. chemical or microbiological);

c) date of collection;

d) time of collection;

e) name of sampling operative;

f) field observations;

g) water temperature;

h) ambient temperature;

i) nature of any pre-treatment, including preservation (e.g. refrigeration); and

j) method of collection, e.g. tap fill or dip sample and any details of deviations from expected sampling conditions, standard conditions or sampling practices, such as abnormal ambient temperatures.

8.4.5 The laboratory should be asked to report the time of receipt and the temperature of the inside of sample transit containers on receipt.

8.5 Pre-commission cleaning

8.5.1 Recording of flushing

The flushing of debris from distribution systems should be recorded, listing descriptions of any physical material observed in strainers or ejecting from taps.

NOTE This information can greatly assist future interpretation of any test results. Photographic evidence might also be helpful.

8.5.2 Non-microbiological parameters

To permit reference to a representative set of data when the results of disinfection are reviewed, site record sheets should list all test results obtained, together with the following (as relevant):

a) the sample location, e.g. floor and room number;

b) the instrument used, e.g. a pH meter, so its calibration details can be cross-referenced;

c) a record of any samples taken for laboratory testing;

d) clear expression of the units of test, for example electrical conductivity expressed as μScm^{-1} or $mScm^{-1}$;

e) the duration of the disinfection exercise, time of dosing, time flushing started and time flushing completed;

f) a record of the residual disinfection concentration at the time of certification of flushing; and

g) date and time of sampling.

NOTE It is also good practice to record the calibration details of the instrument.

8.5.3 Microbiological parameters

Site record sheets should list all test results obtained, including those listed in **4.5.1.3**c), and disinfection residuals (taken concurrently with the microbiological samples).

8.5.4 Samples that might be used for legal purposes

NOTE Such samples include those required to demonstrate completion of predefined contractual obligations, such as suitability to allow human consumption, or from an investigation of microbiological contamination.

8.5.4.1 If deemed necessary at the sample planning stage, a chain of custody should be established so that continuity of evidence can be demonstrated by documentation additional to that normally used for routine samples, showing by signature, dates and time who was responsible for the samples at all times between the moment they were taken and the completion of the analyses.

8.5.4.2 The chain of custody should identify the sampling operative, the person delivering the sample to a collection depot, if different, the laboratory courier, and verification that all parts of the sample, for example chemical and microbiological, that were sent have been received. Under such circumstances, the courier should be asked to provide on request a delivery receipt and the name and contact details of the courier.

8.5.4.3 A completed delivery record and a certified copy of the sample custody document should be returned to the sampling originator, with a copy retained by the laboratory. Alternatively, if the samples are delivered outside normal office hours, some proof that the sample is deposited securely at the depot should be obtained. In addition, prior arrangement should be made with the laboratory for a traceable identification to be included on the test report in order to link clearly the sampling and laboratory reports.

Annex A (informative)

Procedure for sampling swimming, spa and hydrotherapy pool water in operational use (based on Pool Water Treatment Advisory Group, 2009 [15])

Swimming and spa pools ought to be tested once a month for microbiological quality, with spot-checks conducted as necessary if there are problems with the plant, after contamination (or as part of an investigation into an outbreak of illness) or if the pool has been shut down for any reason. Further tests are necessary in response to adverse results.

Hydrotherapy pools, including those not in a healthcare setting, ought to be tested at least once a week depending on bathing load.

Samples are taken with the pool in use, preferably when heavily loaded or immediately afterwards, and ideally at the deep end, away from inlets, using containers of a material that will not affect the sample either microbiologically or chemically, e.g. shatterproof plastic-coated glass or plastic. Leisure pools with complex water flows to different areas might require several samples.

Bottles need to be sterile and contain an agent that neutralizes the pool disinfectant: sodium thiosulfate pentahydrate (18mg/L) is the agent for chlorine and bromine-based disinfectants and deals with up to 5mg\L of free chlorine between pH 6.5 and 9.5. Above this the test might be invalid. 0.1 mL of a freshly prepared 1.8% m/v sodium thiosulfate pentahydrate solution is added for each 100 mL of sample to be collected.

To take a sample, the stopper or cap is first removed, making sure that nothing touches the inside of the bottle or cap. While the bottle is being plunged into the water the long axis is kept approximately horizontal but with the neck pointing slightly upwards to avoid loss of the neutralizing agent. The bottle is then quickly immersed 100 mm to 300 mm below the pool surface, at which point the bottle is tilted upwards to allow it to fill. On removal from the water, the cap is immediately replaced, the sample shaken to disperse the neutralizer, and the bottle is then sent to the laboratory without delay, to arrive there ideally within 4 h of sampling.

Bacteriological samples are analysed as quickly as possible and, in any event, within 24 h of the samples being taken. Between sampling and dispatch, samples are stored away from the light at (5 ±3) °C and, ideally, transported in a refrigerated vehicle, or at least in a freezer box with ice blocks. (The sample container is kept away from direct contact with the freezer packs.)

Water samples for *Legionella* determination are preferably analysed within 24 h of sampling, and not more than 48 h. Samples are stored in the dark at room temperature if immediate analysis is not possible.

Samples submitted for analysis are clearly labelled with the relevant information, e.g. the client's name, site, sample point, date and time and the analysis required, and are accompanied by the on-site test results taken at the time of sampling: free chlorine, combined chlorine and pH, which are necessary for the correct interpretation of bacteriological results.

Annex B (informative) Statistical approaches to the interpretation of monitoring and investigative data

B.1 Use of the term "sample"

This annex describes statistical approaches that can be applied to data collected as a result of monitoring. The word "sample" in the statistical context of this annex has a specific meaning and is not to be confused with the physical samples collected by the sampling operatives.

B.2 Population and the sample (based on Millard 2013 [16])

The most important step of any monitoring is the design of the sampling programme. A good sampling design is required, as the monitoring is only as good as the data upon which it is based. No amount of statistical theory or technique can recover monitoring that has produced:

a) poor quality data;

b) not enough data; or

c) data irrelevant to the issue they were meant to address.

In statistics "population" and "sample" have specific meanings. The term population is defined by the question asked; it is the entire collection of measurements about which we want to make a statement. (Zar 2010 [17]; Berthouex and Brown 2002 [18]; Gilbert 1987 [19]).

For example, if the question is "What is the concentration of chlorine in a building's water system?", then the question needs to be refined until a suitable population can be defined, e.g. "What is the average concentration at a particular outlet over a 5-day period at a specified time of day?" In this example the population is the set of all possible measurements of the concentration of chlorine from that particular outlet during the time period.

A statistical sample is defined as some subset of the population. If the sample contains all components of the population it is called a census. In most cases the population is too large to take a census and a portion of the population is sampled. (Zar 2010 [17]; Berthouex and Brown 2002 [18]; Gilbert 1987 [19]).

B.3 Random versus judgment sampling

B.3.1 Judgement sampling

Judgment sampling does not refer to using prior information and the knowledge of experts to define the area of concern or the population, or plan the study.

Judgement sampling involves the subjective selection of the population by a person or team of people. For example, the number of samples and sampling locations might be determined based on expert opinion or historical information. Some judgement sampling could be described as "haphazard" with the approach being "any sample will do", or "convenience" sampling where samples are taken in convenient places or times. The uncertainty inherent in the results of a judgment sample cannot be quantified and statistical methods cannot be applied.

B.3.2 Probability sampling

Probability sampling or random sampling involves using a random mechanism to select samples from the population. In simple terms, a simple random sample is used in which each member of the population does not influence the selection of any other member. All statistical methods used to quantify uncertainty assume some form of random sampling has been used to obtain a sample. Random sampling can take several forms: simple, systematic and stratified (see Table B.1).

Table B.1 **Sampling strategies and their advantages and disadvantages**

Probability strategy	Application	Advantages	Disadvantages
Simple random sampling	When the population members are similar to one another on important variables	Ensures a high degree of representativeness	Time-consuming and monotonous
Systematic sampling	When the population members are similar to one another on important variables	Ensures a high degree of representativeness, and no need to use a table of random numbers	Less random than simple random sampling
Stratified sampling	When the population is heterogeneous and contains several different groups, some of which are related to the topic of the study	Ensures a high degree of representativeness of all the strata or layers in the population	Time-consuming and monotonous

An enormous number of factors can influence the result associated with a single physical sample, including:

a) the sampling operative;

b) the device used to collect the physical sample;

c) the weather and field conditions;

d) the time the physical sample was collected and delivered to lab;

e) the method of analysis; and

f) the laboratory to which the physical samples were sent.

A good sampling (monitoring) plan controls as many potentially influencing factors as possible, and randomizes the factors that cannot be controlled. Other general objectives of the monitoring strategy include:

1) reducing sampling error as the major goal of any selection technique;

2) a sufficiently large statistical sample to answer the study question, but not so large that the process of data collection becomes uneconomical;

   NOTE In general, the larger the data sample, the smaller the sampling error influence.

3) allowing for lost or corrupted data; and

4) an appropriate number of samples.

B.4 The treatment and use of censored data (based on Helsel 2012 [20])

Censored observations are recorded data such as:

a) low-level concentrations of organic or inorganic chemical, with values known only to be somewhere between zero and the laboratory's detection/reporting limits; and

b) high or low counts of microorganisms described as less than or greater than numerical reporting limits.

For example, measurements are considered too imprecise to report as a single number, so the value is commonly reported as being less than a determination threshold such as <1. This information is often considered second class data and complicates the familiar computations of:

1) descriptive statistics;

2) testing differences among groups;

3) correlation coefficients; and

4) regression equations.

Statisticians use the term "censored data" for observations that are not quantified, but are known to exceed or be less than a threshold value. Values below a threshold ("less than") are left-censored (also termed "non-detects"). Values that exceed a threshold ("greater than") are right-censored data. Values known only to be within a range (e.g. between 10 and 100) are interval-censored data.

Techniques for computing statistics for censored data have been employed for many years where the length of time is measured until an event occurs. Methods for incorporating censored data when computing the familiar statistical computations are commonly used in medical studies and some industrial sectors, without substituting arbitrary values. These methods are commonly called "survival analysis" (Klein and Moeschberger 2003 [21]) and can be readily applied to the monitoring described in this British Standard and any similar collection of water quality or environmental data.

It is bad practice, when dealing with censored data, to exclude or delete them as this produces a strong bias in all subsequent numerical interpretations or hypothesis tests. For example, excluding the 80% of observations that are left-censored non-detects and reporting the mean of the remaining 20% would provide almost no insight into the original data. The fabrication (substitution) of censored data with artificial values, as if these had been measured, for example using the limit of detection, is often used for evaluation purposes. While substitution is better than the deletion of censored values, it adds an invasive signal to the data that was not previously there, potentially obscuring the information present in the measured observations. Fabrication, substitution using one-half the reporting limit, is a common convention in the UK, but this has been found to be a poor method for computing descriptive statistics for data sets containing censored information (see Helsel 2012 [20] for a list of references). A practical guide for applying statistical techniques to censored data, based on "survival analysis", can be found in Helsel 2012 [20], Millard 2013 [16] and the US EPA (*Free to air*) Statistical Software ProUCL 5.0.00 [1)]).

[1)] http://www.epa.gov/osp/hstl/tsc/software.htm [viewed: 16 September 2015].

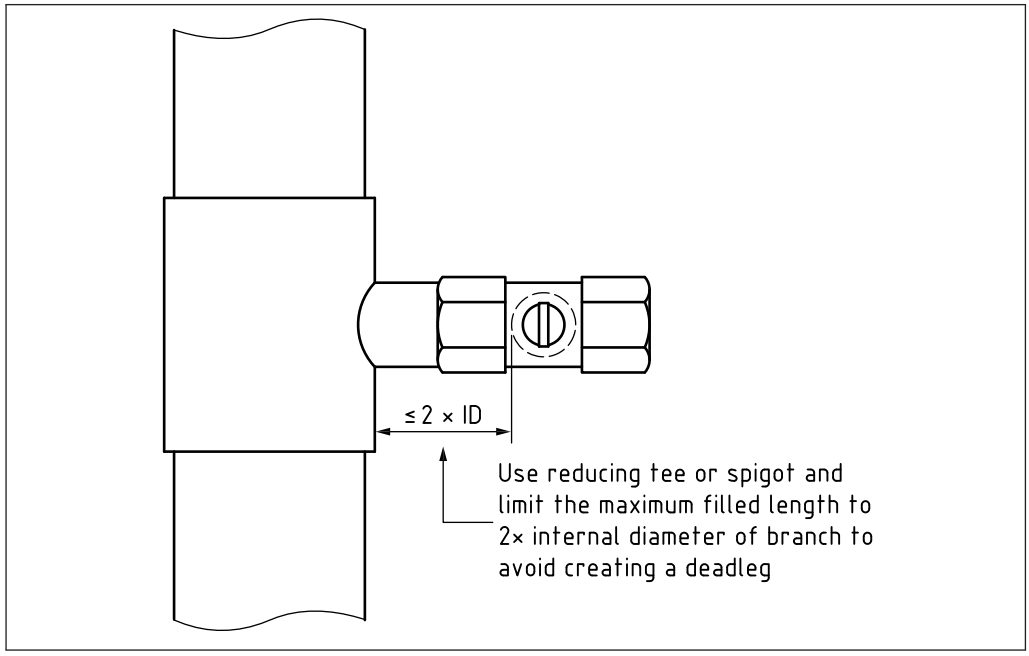
Annex C (informative) Dedicated sampling points

C.1 General

The sampling valve ought to be 15 mm or less and fitted as close as physically possible to the supply pipe, using a reduced tee or spigot. A quarter-turn ball valve is suitable for the sampling valve (see Figure C.1). For small diameter pipe (15 mm or less) it might be appropriate to fit a 3-port ball valve in-line.

Dedicated sampling points may be fitted where the mains water enters the building and where sampling from the available outlets would be inappropriate or impractical.

Figure C.1 **Dedicated sampling point**



C.2 Labelling

All sample taps need to be permanently identified with a unique sample site number, which can be cross-referenced with the following;

- the location name;
- the required flushing time;
- a statement of the function of the sample point;
- the label mounted local to the sample tap such that it is clearly visible to a sampling operative when taking a sample;
- instructions if a sample pump is installed; and
- emergency action limit if any on-site test is carried out.

A bar code may be used for handheld data capture.

C.3 Materials

Only materials and fittings listed in the current *Water Fittings and Materials Directory* published by the Water Regulations Advisory Scheme (WRAS) [22] can be used in the sampling point assembly.

Pipework ought to be a single length of 15 mm copper with no underground joints.

Plastic pipework needs to be impervious to light and not affect the water quality of the sample in any way, and conform to BS 6920-1.

The outlet needs to be made of metal (stainless steel/brass) and have no attachments or inserts, except for a nipple/spout arrangement for flaming and to enable a controlled flow.

It might be appropriate for the tap orifice to have a dust cap to prevent ingress from insects/dirt.

C.4 Location of dedicated sample outlets

Sample outlets need to be located on pipework leaving any storage tank to be sampled, as close as practicable to the storage tank, bearing in mind the need for safe and convenient access to the outlet by a lone sampling operative carrying any sample bottles required.

Where the opportunity exists to influence the design of sample outlet locations, the following factors need to be applied where possible:

- avoid confined spaces;
- avoid the need for ladders;
- avoid underground chambers;
- leave a sufficient distance downstream of any chemical dosing point or point where two streams of water blend, to ensure that complete mixing has occurred;
- avoid areas of low flow, such as dead ends in pipes, or close to the walls or corners of tanks; or
- comprise tappings to ensure that samples are not affected by sediment in the base of the main or air in the top.

Annex D (normative) Water sampling bottles

Table D.1 **Water sampling bottles for commonly measured parameters** *(1 of 2)*

Test	Example bottle type [A)]	Treated?	Directions for use	Delivery to lab
Coliforms, *E.coli*, *Enterococcus*, *Clostridia perfringens*, TVC measured at 22 °C and 37 °C, *Pseudomonas aeruginosa*, and bacterial flow cytometry	Plastic	Yes	• Fill and leave a small air gap • Do not rinse • Refrigerate sample: (5 ±3)°C [B)]	Ideally same day but within 24 h
Legionella	Plastic	Yes	• Fill and leave a small air gap • Do not rinse • Clearly mark to avoid sample being refrigerated (<20 °C) • Keep sample out of direct sunlight	Ideally within 24 h but within 48 h
Salmonella	Plastic	No	• Fill and leave a small air gap • Do not rinse • Refrigerate sample	Within 24 h
Qualitative and quantitative taste and odour	Plastic	Yes	• Fill completely • Refrigerate sample	Within 48 h
Poly aromatic hydrocarbons	Glass	Yes	• Fill completely • Do not rinse • Refrigerate sample	Within 72 h
Appearance, conductivity, pH, redox potential, turbidity, UV and colour	Plastic	No	• Fill completely • Refrigerate sample	Within 72 h
Total and dissolved calcium, magnesium, sodium, boron, barium, phosphorus, sulfate, aluminium, copper, iron, lead, manganese and zinc	Plastic	No	• Fill completely	Within 48 h
Dissolved aluminium, copper, iron, lead, manganese and zinc	Plastic	No	• Fill completely	Within 48 h
Arsenic, selenium, chromium, nickel, cadmium, antimony and mercury	Plastic	Yes	• Fill completely • Do not rinse	Within 72 h
Total cyanide	Darkened plastic	Yes	• Fill completely • Do not rinse	Within 72 h

Table D.1 **Water sampling bottles for commonly measured parameters** *(2 of 2)*

Test	Example bottle type [A)]	Treated?	Directions for use	Delivery to lab
Biochemical and chemical oxygen demand, dissolved oxygen, kjeldahl nitrogen, permanganate index, suspended solids, total solids, total dissolved solids, volatile solids	Plastic	No	• Fill completely • Refrigerate sample	Within 24 h
Alkalinity, ammonium, chloride, nitrate, soluble reactive phosphate, TOC	Plastic	No	• Fill completely • Refrigerate sample	Within 72 h

[A)] The type, size, shape and volume of the bottle and the method used is determined by the laboratory.

[B)] Maintaining a suitably consistent and accurate (5 ±3) °C is difficult when using artificial ice packs, as the temperature in such circumstances varies as a result of external temperatures, the volume and insulating characteristics of the cool bag/box, and the mass/number of the samples and their initial temperature.

NOTE It is recommended that the intended laboratory is consulted on the size and type of container before samples are taken. More guidance is given in BS 7592, BS EN ISO 19458, HTM 04-01 [2] and BS EN ISO 5667-3.

Table D.2 **Water sampling bottles for other parameters** *(1 of 2)*

Test	Example bottle type [A)]	Treated?	Directions for use	Delivery to lab
Algal identification, Chlorophyll A and microscopy	Plastic	No	• Fill completely • Refrigerate sample	Within 72 h
Algal toxins	Glass	Yes	• Fill completely • Do not rinse • Refrigerate sample	Within 48 h
Haloacetic acids	Darkened glass	Yes	• Do not rinse before filling • Fill to top without overflowing • Refrigerate sample	Within 96 h
Bromate, bromide, chlorate, chlorite, fluoride and perchlorate	Darkened glass	No	• Fill completely • Do not rinse • Refrigerate sample	Within 72 h
Phenoxy acid herbicides	Glass	Yes	• Fill completely • Do not rinse • Refrigerate sample	Within 72 h
Anionic detergents	Plastic	No	• Fill completely • Refrigerate sample	Within 72 h
EPA = triazines, urons, carbofuran and conazols; EPA 1 = THMs; EPA 2 = VOCs; EPA 3 = alcohols; EPA 4 = furfural; EPA 5 = triazinylsulfonylurea herbicides, carbendazim and metazchlor; EPA 6 = asulam; EPA 7 = mixed pesticides and fungicides; EPA 8 = glycols	Darkened glass	Yes	• Fill completely • Do not rinse • Refrigerate sample	Within 72 h
GCMS scan, geosmin, MIB, organotin, SVOCs	Glass	Yes	• Fill completely • Do not rinse • Refrigerate sample	Within 72 h
Nitrosamine, organochlorine pesticides and organophosphorus pesticides	Glass	Yes	• Fill completely • Do not rinse • Refrigerate sample	Within 72 h

Table D.2 **Water sampling bottles for other parameters** *(2 of 2)*

Test	Example bottle type [A)]	Treated?	Directions for use	Delivery to lab
Gross alpha/beta and tritium	Large plastic	No	• Fill completely • Refrigerate sample	Within 72 h
Mancozeb and metaldehyde	Glass	Yes	• Fill completely • Do not rinse • Refrigerate sample	Within 72 h
Alkyl phenyl ethoxylates and sulcofuran	Glass	Yes	• Fill completely • Do not rinse • Refrigerate sample	Within 72 h
Phenols	Glass	Yes	• Fill completely • Do not rinse • Refrigerate sample	Within 72 h

[A)] The type, size, shape and volume of the bottle and the method used is determined by the laboratory.

NOTE It is recommended that the intended laboratory is consulted on the size and type of container before samples are taken. More guidance is given in BS 7592, BS EN ISO 19458, HTM 04-01 [2] and BS EN ISO 5667-3.

Annex E (informative) Example procedure for investigating recurring poor results from a shower

E.1 Objective

The objective of the procedure set out in this annex is to determine if the supply feeds are microbiologically contaminated or if local components have become colonized.

This procedure can be followed in the event of a positive *Legionella* result or other microbiological parameter being reported outside a control value where there is a procedural requirement to retest the location after mitigation measures have been applied.

E.2 Procedure

E.2.1 If required for verification, re-sample the shower in accordance with Clause **5**, ensuring the exposure risk from the production of aerosols is minimal.

E.2.2 Remove the showerhead and flexible hose. Record the condition of the outlet with respect to the presence of hardness scale or slimes.

E.2.3 If required for identification of the potential source of contamination, sample the orifice outlet (with shower head/hose removed) in accordance with Clause **5**.

E.2.4 Access the hot water and cold water supply to the shower area.

E.2.5 Remove, clean and disinfect TMV pre-filters and inspect TMV components, replacing if visibly fouled. Swabbing might be more appropriate to limit aerosol production.

E.2.6 Sample the hot water and cold water supplies individually in accordance with Clause **6**.

E.2.7 Allow the water to flow from each outlet, measuring the temperature for up to 2 min on the cold outlet and 1 min on the hot outlet.

E.2.8 Clean and disinfect or replace the flexible hose and shower head.

E.2.9 Re-install all items and flush for several minutes.

E.2.10 For verification, re-sample the shower in accordance with Clause **5**.

E.3 Interpretive postulation

E.3.1 If both hot and cold supplies to the TMV yield positive or out-of-specification results, the implication is that the local hot and cold water system is colonized and systemic treatment and remedial actions are required.

E.3.2 If either one of the supplies yields positive or out-of-specification results, the implication is that this system is colonized and systemic treatment and remedial actions are likely to be required.

E.3.3 If both supplies to the TMV yield no out-of-specification results, then the likely cause of poor results is local and present in the TMV or shower hose and head.

E.3.4 Where a TMV outlet sample was collected, and this yields no out-of-specification results, then the shower head or hose is the likely source of contamination.

Annex F (informative) Disinfectant preparation

F.1 Process for preparing a chlorine disinfectant solution

F.1.1 Equipment

F.1.1.1 *Protective gloves (disposable or non-disposable).*

F.1.1.2 *Safety glasses.*

F.1.1.3 *Plastic bottle with large cap, with 500 mL mark.*

F.1.1.4 *One beaker/measuring cylinder.*

F.1.1.5 *Chlorine testing kit.*

F.1.1.6 *Four 2.5 g sodium dichloroisocyanurate tablets.*

F.1.1.7 *Container for waste chlorine disinfectant solution.*

F.1.2 Preparation of chlorine disinfectant solution

NOTE This solution needs to be prepared freshly each day it is required.

F.1.2.1 Check that the sodium dichloroisocyanurate tablets (see **F.1.1.6**) are within the manufacturer's use-by date before use.

F.1.2.2 Put on the safety glasses (see **F.1.1.2)** and disposable or non-disposable gloves (see **F.1.1.1**).

F.1.2.3 Fill the plastic bottle (see **F.1.1.3**) approximately one third-full with distilled/deionized water obtained from the laboratory or, if this is not available, tap water.

F.1.2.4 Slowly and cautiously add the four (2.5 g) sodium dichloroisocyanurate tablets (see **F.1.1.6**) one at a time, and swirl the bottle until all the tablets have dissolved. Carry this out in a fume cupboard, if possible, or in a well-ventilated area, because gases are given off as the tablets dissolve. Avoid breathing these gases.

F.1.2.5 Make up to the 500 mL mark on the bottle (see **F.1.1.3**) with distilled/deionized water or tap water from a beaker (see **F.1.1.4**). Place the cap on the bottle and gently invert to mix the solution.

F.1.2.6 Label the bottle "Tap disinfectant solution 1% w/v available chlorine" and "Make solution fresh daily".

F.1.2.7 Change the safety gloves worn whilst preparing this solution before handling sample bottles or carrying out chlorine residual tests.

F.2 Disinfectant wipes

Proprietary disinfectant wipes can be used to clean surfaces:

a) that are not intended to come into contact with drinking water, but which pose a risk of cross-contaminating a sample, sample container or stored water (e.g. inspection hatch covers); and

b) for which spraying with chlorine solution (see **F.1**) is not practical, e.g. during the preparation of areas for sampling and maintenance of equipment, such as bottle boxes or dedicated tools such as pliers, spanners and valve keys.

The preferred disinfection formulations on such wipes are those based on 2-bromo-2-nitropropane-1,3-diol (CAS Number 52-51-7), sometimes referred to as "Bronopol". Alternatives may be used, provided it can be demonstrated that the performance of their active ingredients matches that published for Bronopol for the microbiological inhibitory performance for *Escherichia coli*, *Pseudomonas aeruginosa* and *Legionella pneumophila*. Propan-2-ol can also be used, but is unlikely to be as effective against microbiological contamination (see [23], [24] and [25]).

Annex G (informative) Example documents used to avoid deviating samples

Figure G.1 **Example log**

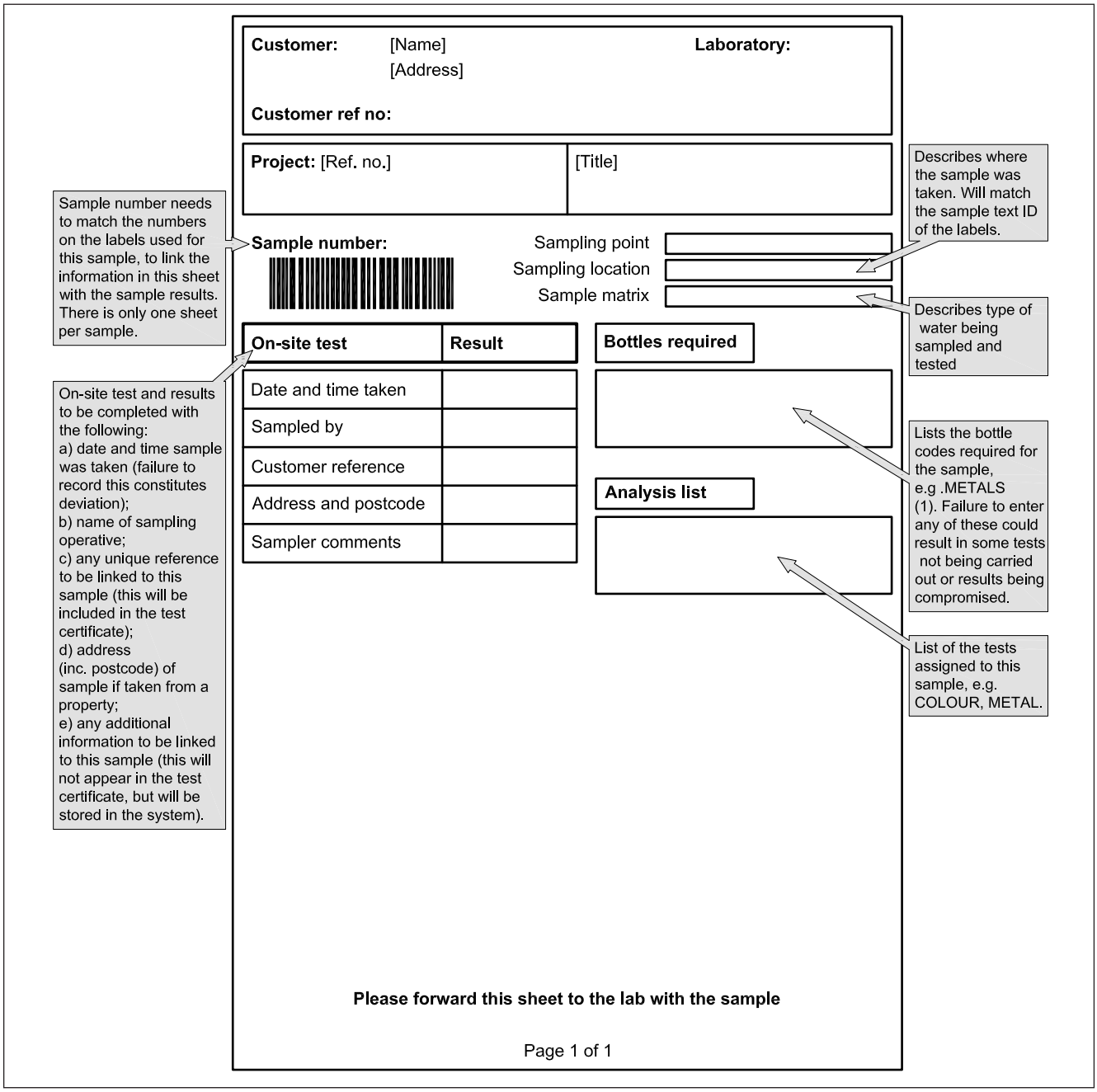


Figure G.2 **Example sample stability information**

Laboratory:

Lab method code	Lab test	Available sample matrix	Sample stability time (days)	Temp. dependent? [Stored at (5 ±3) °C]	Comments
GIC003/IC002	Colour (unchlorinated samples)	Wholesome/raw	12	Yes	
GIC003/IC002	Colour (chlorinated samples)	Wholesome/raw	4	Yes	
GIC003/IN33	Turbidity	Wholesome/raw	4	Yes	
GIC003/IN37	Ph	Wholesome/raw	5	Yes	
GIC003/IN38	Conductivity	Wholesome/raw	5	Yes	
IC009	Chloride	Wholesome/raw	28	Yes	
D40	Total dissolved solids	Wholesome/raw	21	No	
D45.1	Total organic carbon	Wholesome/raw/swimming pool/final	8	Yes	
IC071	Chemical oxygen demand	Wholesome/raw/final/crude/ trade/leachate	2	Yes	
GIC001	Metal, iron, manganese	Wholesome/raw	28	No	
ICPMS1	Mercury	Wholesome/raw	21	No	
ICPMS1	Cadmium, selenium, chromium	Wholesome/raw	28	No	
ICPOES1	Metal, iron, selenium	Wholesome/raw	14	No	
ICPOES2	Lead, sulfate	Wholesome/raw	1	Yes	
MD07	Coliform/*E. coli*	Wholesome/raw/waste	1	Yes	
MD03	22 °C and 37 °C TVC counts	Wholesome/raw	1	Yes	
MD05	*Clostridia perfringens*	Wholesome/raw	1	Yes	
MD04	*Faecal Strep.*	Wholesome/raw	1	Yes	
MD009	*Pseudomonas aeruginosa*	Swimming pool	1	Yes	
MW010	*Legionella*	Wholesome/raw	1	No	Store sample at ambient temp.
MP18	*Cryptosporidiosis*	Wholesome/raw/swimming pool	3	Yes	

Bibliography

Standards publications

For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS 853-1:1990+A3:2011, *Specification for vessels for use in heating systems – Part 1: Calorifiers and storage vessels for central heating and hot water supply*

BS 1427, *Guide to on-site test methods for the analysis of waters*

BS 6920-1, *Suitability of non-metallic materials and products for use in contact with water intended for human consumption with regard to their effect on the quality of the water – Part 1: Specification*

BS 8550, *Guide for the auditing of water quality sampling*

BS 8558:2015, *Guide to the design, installation, testing and maintenance of services supplying water for domestic use within buildings and their curtilages – Complementary guidance to BS EN 806*

BS EN ISO 16266, *Water quality – Detection and enumeration of* Pseudomonas aeruginosa *– Method by membrane filtration*

BS EN ISO 19458, *Water quality – Sampling for microbiological analysis*

BS EN ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

BS ISO 5667-5, *Water quality – Sampling – Part 5: Guidance on sampling of drinking water from treatment works and piped distribution systems*

BS ISO 17381, *Water quality – Selection and application of ready-to-use test kit methods in water analysis*

Other publications

[1] WORLD HEALTH ORGANIZATION (WHO). *Guidelines for Drinking-Water Quality*. 3rd edition. Geneva: WHO. 2004.

[2] DEPARTMENT OF HEALTH. *Water systems. Health Technical Memorandum 04-01: Addendum. Pseudomonas aeruginosa – advice for augmented care units*. 2013. https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/140105/Health_Technical_Memorandum_04-01_Addendum.pdf [viewed: 16 September 2015].

[3] ENVIRONMENT AGENCY STANDING COMMITTEE OF ANALYSTS (SCA). *The Microbiology of Drinking Water (2010) – Part 8 – The isolation and enumeration of Aeromonas and Pseudomonas aeruginosa by membrane filtration*. Bristol: Environment Agency. 2010.

[4] PUBLIC HEALTH ENGLAND. *Examining food, water and environmental samples from healthcare environments. Microbiological Guidelines*. London: Public Health England. 2013.

[5] GREAT BRITAIN. The Health and Safety at Work etc. Act 1974. London: HMSO.

[6] GREAT BRITAIN. The Management of Health and Safety at Work Regulations 1999. London: TSO.

[7] GREAT BRITAIN. The Control of Substances Hazardous to Health Regulations 2002, as amended. London: TSO.

[8] HEALTH AND SAFETY EXECUTIVE. *Legionnaires' disease: The control of legionella bacteria in water systems*. Approved Code of Practice L8 (Fourth edition). HSE Books. 2013. www.hse.gov.uk/pubns/books/l8.htm [viewed: 16 September 2015].

[9] HEALTH AND SAFETY EXECUTIVE. HSG274 Part 2. *Legionnaires' disease: Part 2: The control of legionella bacteria in hot and cold water systems*. HSE Books 2014.

[10] ENGLAND AND WALES. The Water Supply (Water Fittings) Regulations 1999, as amended. London: The Stationery Office.

[11] SCOTTISH WATER. The Water Supply (Water Fittings) (Scotland) Byelaws 2014. http://www.scottishwater.co.uk/assets/business/files/water%20byelaws%20documents/watersupplywaterfittingsscotland byelaws2014.pdf [viewed: 16 September 2015].

[12] NORTHERN IRELAND. The Water Supply (Water Fittings) Regulations (Northern Ireland) 2009. London: The Stationery Office.

[13] CHARTERED INSTITUTION OF BUILDING SERVICES ENGINEERS. TM13: *Minimising the Risk of Legionnaires' Disease*. London: CIBSE. 2013.

[14] DRINKING WATER INSPECTORATE (DWI). *Guidance on the implementation of the Water Supply (Water Quality) Regulations 2002 (as amended) in England*. Version 1.1. London: DWI. March 2012. http://dwi.defra.gov.uk/stakeholders/guidance-and-codes-of-practice/WS(WQ)-regs-england2010.pdf [viewed: 16 September 2015].

[15] POOL WATER TREATMENT ADVISORY GROUP (PWTAG). *Swimming Pool Water – Treatment and quality standards for pools and spas*. Diss: PWTAG Ltd. 2009.

[16] MILLARD S P. *EnvStats: An R Package for Environmental Statistics*. 2nd edition. New York: Springer. 2013. ISBN 978-1-4614-8455-4.

[17] ZAR J H. *Biostatistical analysis*. Prentice-Hall/Pearson. 2010.

[18] BERTHOUEX P M and BROWN L C. *Statistics for Environmental Engineers*. 2nd edition. CRC Press Limited. 2002.

[19] GILBERT R O. *Statistical Methods for Environmental Pollution Monitoring*. John Wiley & Sons. 1987.

[20] HELSEL D R. *Statistics for Censored Environmental Data Using Minitab and R*. 2nd edition. Hoboken: Wiley. 2012. ISBN 978-0-470-47988-9.

[21] KLEIN, J P and MOESCHBERGER, M L. *Survival Analysis. Techniques for Censored and Truncated Data*. 2nd Edition. USA: Springer. 2003.

[22] WATER REGULATIONS ADVISORY SCHEME (WRAS). *Water Fittings and Materials Directory*. http://www.wras.co.uk/Directory/ [viewed: 16 September 2015].

[23] Manufacturer's information June 2009 BASF – EMV080611e/00.

[24] HAJIME SAITO and TETSUO ONODA. *Antibacterial action of bronopol on Various bacteria, especially on pseudomonas aeruginosa*. Chemotherapy. November 1947.

[25] BRYCE, D M, CROSHAW B, HALL, J E, HOLLAND, V R, and LESSEL, B. The activity and safety of the antimicrobial agent Bronopol (2-bromo-2-nitropropan.1,3-diol). *J. Soc. Cosmet. Chern*. 29 3-24 (1978).

Further reading

AUMERAN C, PAILLARD C, ROBIN F, et al. *Pseudomonas aeruginosa* and *Pseudomonas putida* outbreak associated with contaminated water outlets in an oncohaematology paediatric unit. *The Journal of hospital infection* 2007; **65**(1): 47-53.

DEPARTMENT OF ENVIRONMENT NORTHERN IRELAND (DOENI). *Guidance for the monitoring of cryptosporidium in treated water supplies in Northern Ireland*. 1st edition. Belfast: DOENI. 2002 (revised 2003). http://www.doeni.gov.uk/niea/ crypto_guidance_april05.pdf [viewed: 16 September 2015].

DUROJAIYE OC, CARBARNS N, MURRAY S, MAJUMDAR S. Outbreak of multidrug-resistant *Pseudomonas aeruginosa* in an intensive care unit. *The Journal of hospital infection* 2011; **78**(2): 154-5.

ENVIRONMENT AGENCY STANDING COMMITTEE OF ANALYSTS (SCA). *The Microbiology of Drinking Water (2012) – Part 7 – Methods for the enumeration of heterotrophic bacteria, Methods for the Examination of Waters and Associated Materials*. Nottingham: SCA. 2012.

ENVIRONMENT AGENCY STANDING COMMITTEE OF ANALYSTS (SCA). *The Microbiology of Drinking Water (2010) – Part 14 – Methods for the isolation, identification and enumeration of Cryptosporidium oocysts and Giardia cysts*. Bristol: Environment Agency. 2010.

FERRONI A, NGUYEN L, Pron B, QUESNE G, BRUSSET MC, BERCHE P. Outbreak of nosocomial urinary tract infections due to *Pseudomonas aeruginosa* in a paediatric surgical unit associated with tap-water contamination. *The Journal of hospital infection* 1998, **39**(4): 301-7.

HEALTH PROTECTION AGENCY (HPA). *Management of Spa Pools: Controlling the Risks of Infection – Part 2: Guidance on the control of infectious diseases in spa pools*. Health Protection Agency. London: HPA. 2006.

WORLD HEALTH ORGANIZATION (WHO). *Water safety in buildings*. Geneva: WHO. 2011

WORLD HEALTH ORGANIZATION (WHO). *Guidelines for drinking-water quality*. Fourth edition. Geneva: WHO. 2011.

This page deliberately left blank

British Standards Institution (BSI)

BSI is the national body responsible for preparing British Standards and other standards-related publications, information and services.

BSI is incorporated by Royal Charter. British Standards and other standardization products are published by BSI Standards Limited.

About us

We bring together business, industry, government, consumers, innovators and others to shape their combined experience and expertise into standards -based solutions.

The knowledge embodied in our standards has been carefully assembled in a dependable format and refined through our open consultation process. Organizations of all sizes and across all sectors choose standards to help them achieve their goals.

Information on standards

We can provide you with the knowledge that your organization needs to succeed. Find out more about British Standards by visiting our website at bsigroup.com/standards or contacting our Customer Services team or Knowledge Centre.

Buying standards

You can buy and download PDF versions of BSI publications, including British and adopted European and international standards, through our website at bsigroup.com/shop, where hard copies can also be purchased.

If you need international and foreign standards from other Standards Development Organizations, hard copies can be ordered from our Customer Services team.

Subscriptions

Our range of subscription services are designed to make using standards easier for you. For further information on our subscription products go to bsigroup.com/subscriptions.

With **British Standards Online (BSOL)** you'll have instant access to over 55,000 British and adopted European and international standards from your desktop. It's available 24/7 and is refreshed daily so you'll always be up to date.

You can keep in touch with standards developments and receive substantial discounts on the purchase price of standards, both in single copy and subscription format, by becoming a **BSI Subscribing Member**.

PLUS is an updating service exclusive to BSI Subscribing Members. You will automatically receive the latest hard copy of your standards when they're revised or replaced.

To find out more about becoming a BSI Subscribing Member and the benefits of membership, please visit bsigroup.com/shop.

With a **Multi-User Network Licence (MUNL)** you are able to host standards publications on your intranet. Licences can cover as few or as many users as you wish. With updates supplied as soon as they're available, you can be sure your documentation is current. For further information, email bsmusales@bsigroup.com.

BSI Group Headquarters

389 Chiswick High Road London W4 4AL UK

Revisions

Our British Standards and other publications are updated by amendment or revision.

We continually improve the quality of our products and services to benefit your business. If you find an inaccuracy or ambiguity within a British Standard or other BSI publication please inform the Knowledge Centre.

Copyright

Useful Contacts:

Customer Services
Tel: +44 845 086 9001
Email (orders): orders@bsigroup.com
Email (enquiries): cservices@bsigroup.com

Subscriptions
Tel: +44 845 086 9001
Email: subscriptions@bsigroup.com

Knowledge Centre
Tel: +44 20 8996 7004
Email: knowledgecentre@bsigroup.com

Copyright & Licensing
Tel: +44 20 8996 7070
Email: copyright@bsigroup.com

bsi.

...making excellence a habit.™