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Code of practice for the preparation, commissioning and maintenance of domestic central heating and cooling water systems

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Contents

Summary of pages

This document comprises a front cover, and inside front cover, pages i to iv, pages 1 to 11, 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 31 May 2019. It was prepared by Technical Committee CII/62, *Treatment of water for boilers.* A list of organizations represented on this committee can be obtained on request to its secretary.

Supersession

This British Standard supersedes BS 7593:2006, which is withdrawn.

Information about this document

This is a full revision of the standard, and introduces the following principal changes:

- a widening of the scope to include open vented or sealed cooling systems in individual domestic premises;
- the addition of a glossary of terms and definitions;
- revised and simplified cleaning and flushing methodologies;
- a new clause on in-line filters; and
- a new clause on testing and ongoing maintenance.

Use of this document

As a code of practice, this British Standard takes the form of guidance and recommendations. It should not be quoted as if it were a specification and particular care should be taken to ensure that claims of compliance are not misleading.

Any user claiming compliance with this British Standard is expected to be able to justify any course of action that deviates from its recommendations.

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.

Where words have alternative spellings, the preferred spelling of the Shorter Oxford English Dictionary is used (e.g. "organization" rather than "organisation").

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.

Particular attention is drawn to the following specific regulations:

- The Water Supply (Water Fittings) Regulations 1999 [1].
- The Health and Safety at Work, etc. Act 1974 [2].
- The Control of Substances Hazardous to Health Regulations 2002 [3].
- The Building Regulations 2000, as amended (particularly Approved Document L1) [4].
- The Building (Scotland) Regulations 2004 [5].
- The Building Regulations (Northern Ireland) Statutory Rules 2000 [6].
- The Trade Effluent (Proscribed Processes and Substances) Regulations 1989 [7].
- The Hazardous Waste (England and Wales) Regulations 2005 [8].
- The Special Waste (Scotland) Regulations 1996 [9].
- The Hazardous Waste (Wales) Regulations 2005 [10].
- The Hazardous Waste Regulations (Northern Ireland) 2005 [11].

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1 Scope

This British Standard gives recommendations on good practice for the preparation of the circulating water in open vented or sealed heating and cooling systems in individual domestic premises during initial commissioning or re-commissioning following major remedial work (e.g. boiler replacement) and the ongoing water treatment to ensure appliance and system protection and continued efficiency in operation.

*NOTE 1 The term "boiler", as used throughout this British Standard, reflects common parlance and refers to the appliance that heats the circulating water in a domestic central heating system (see **3.4**). It does not actually raise steam (i.e. boil the water).*

It does not apply to commercial or municipal premises or to multiple residential premises served by one common circuit, unless that common circuit can be effectively cleaned and flushed with domestic equipment. It does apply to individual heating and cooling circuits within individual dwellings in multiple residential premises.

NOTE 2 For specialized closed circuits, such as those containing solar thermal panels and ground source heat pump loops, refer to the manufacturer's instructions. See also BS 5918 (for solar thermal) and MIS 3005 [12] (for ground source heat pumps).

NOTE 3 For larger closed heating systems such as found in commercial or municipal premises, or the primary systems on residential developments, refer to BSRIA BG 29 [13].

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes provisions of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

BS EN 1717, *Protection against pollution of potable water in water installations and general requirements of devices to prevent pollution by backflow*

BS EN 12828:2012+A1:2014, *Heating systems in buildings — Design for water-based heating systems*

BS EN 14743, *Water conditioning equipment inside buildings — Softeners — Requirements for performance, safety and testing*

3 Terms and definitions

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

3.1 individual domestic premises

private domestic accommodation/dwelling, owned or rented

NOTE Examples of individual domestic premises are house, flat and apartment.

3.2 domestic central heating system

configuration of interconnected components that uses water as a heat transfer medium to distribute centrally generated heat to heat emitters for the space heating of buildings, or parts thereof

[SOURCE: BS EN 12828:2012+A1:2014, **3.1.8**, modified]

NOTE Definition is also adapted from Commission Regulation (EU) No 813/2013 [15].

3.3 domestic central cooling system

configuration of interconnected components that uses the distribution of water below ambient temperature to provide space cooling to buildings, or parts thereof

3.4 appliance

device that heats or cools circulating water in a domestic central heating/cooling system in order to reach and maintain at a desired level the indoor temperature of an enclosed space, such as a building, a dwelling or a room

3.5 hard water

water with a total concentration of dissolved calcium and magnesium salts greater than 200 mg/l (ppm) (as $CaCO_3$)

3.6 naturally soft water

water with a natural total concentration of dissolved calcium and magnesium salts lower than 50 mg/l (ppm) (as $CaCO_3$)

4 Objectives of system water treatment

The primary objectives of water treatment should be to maintain the performance of the appliance and system in terms of providing consistent, on-demand heating or cooling while reducing household energy use and carbon equivalents and guarding against component breakdown. Cleaning and water treatment should be used to preserve, or restore and maintain energy efficiency and system effectiveness; it does so by:

a) removing installation and corrosion debris, oils, greases and flux residues in the case of new systems and corrosion debris and scale for existing systems, and/or microbiological foulants in both cases by cleaning the system;

b) minimizing the corrosion of system metals, without adversely affecting non-metals, such as plastics and rubber;

c) inhibiting the formation of magnetite sludge and other corrosion products;

d) inhibiting the formation of limescale;

e) inhibiting the growth of microbiological organisms; and

f) protecting against freezing.

5 Causes of problems in central heating and cooling systems

5.1 Corrosion

*COMMENTARY ON **5.1***

Corrosion is generally a process of oxidation of metals which, in a central heating or cooling system, can result in restriction of circulation and/or failure of components, e.g. perforation of radiators.

It should be noted that corrosion in a central heating or cooling system is promoted by the following, in no particular order:

a) incorrect, unsuitable or poorly applied or maintained water treatment products;

b) ingress of air, e.g. at mechanical or poorly soldered joints;

NOTE 1 Some plastic pipe allows the ingress of oxygen into the system water (see BS 5955-8). Other sources of oxygen ingress include elastomeric seals, rubber tubing, plastic fittings and other permeable components.

c) poor system design and/or installation, e.g. oxygenation of the circulating water by replenishment, pumping over or sucking down at the open vent, incorrect sizing of the cold feed pipe, inadequately sized or incorrectly installed feed and expansion cistern or vessel;

d) the presence of installation materials in the system water, e.g. flux residues, jointing compounds, residual cleaner, foreign matter left over from inadequate cleaning or flushing, or oils and greases left over from the manufacturing process of system components;

e) certain characteristics of the system supply water, e.g. some naturally soft waters with low alkalinity and low pH are generally more corrosive to system metals; some waters might contain high levels of aggressive anions (e.g. chloride) that can promote pitting of metals;

f) the presence of bacteria (see **5.4**);

g) the accumulation of corrosion products deposited as sludge in the system; and/or

h) electrolytic (galvanic) action between dissimilar metals.

NOTE 2 Less noble (more active) metals such as aluminium, steel and zinc are the most susceptible to this type of corrosion.

Corrosion should be controlled by the avoidance of the circumstances outlined in a) to h), ensuring the system is clean (see Clause **7**) and protected with an adequate corrosion inhibitor (see Clause **9**).

NOTE 3 Corrosion processes are mainly determined by the extent of oxygen ingress into the system. Maintaining complete water and air-tightness, even in closed systems, is impractical and consequently corrosion control by oxygen level control is ineffective. Further information on corrosion in re-circulating systems is given in BS EN 14868.

5.2 Sludge

The formation of sludge should be avoided.

Corrosion by-products usually give rise to sludge. In systems, where air ingress is limited, the majority of sludge consists of black iron oxide, known as magnetite. Red rust might also be present in over-aerated systems. Sludge can be carried around a system and often deposits in low flow areas e.g. radiators. Sludge can also form a scale in heat exchangers and, when combined with limescale, a very hard mixed scale may result.

Sludge is recognized as the most common cause of failure of water carrying components, including boiler heat exchangers, circulator pumps, radiators and controls. It can also prematurely wear other appliance components, such as ignition electrodes, due to increased cycling of the boiler.

Fouling by sludge and/or scale can also restrict flow through any components or areas of the system which have low water velocity, small bore control valves or small pipe diameters, e.g. in microbore circuits. Sludge accumulation results in poor circulation and a decrease in system efficiency and makes biological control more difficult.

5.3 Scale

The formation of limescale should be avoided. This can be achieved by controlling the level of hardness of the system fill water by preventing the ingress of fresh make-up water and by the use of scale inhibitors (usually added as a component of the water treatment together with the corrosion inhibitor).

"Hardness" is the term which describes the total concentration of calcium and magnesium salts dissolved in water. Scaling is the precipitation of these salts alone or with corrosion debris to form deposits within the system. This process is most likely to take place in the hottest part of the system, e.g. a boiler's heat exchanger. Deposited calcium carbonate, or limescale, can also accumulate elsewhere in the system, often in areas of low flow.

The potential for scale formation is greatest in hard water areas of the United Kingdom. When these waters are heated, limescale can form.

NOTE For more information on water hardness across England and Wales see http://dwi.defra.gov.uk/consumers/advice-leaflets/hardness_map.pdf[1]. For further regions across the UK, information on local water hardness can be obtained from municipal water supplier websites.

Limescale which has formed in a heat exchanger has a detrimental effect on appliance heat transfer efficiency. When limescale is combined with sludge in a heat exchanger, a very hard mixed deposit may result.

Scale and/or sludge can also be responsible for boiler noise (kettling).

5.4 Microbiological contamination

Controlling microbiological organisms and their by-products should be taken into account, which can cause problems in a central heating or cooling system; they can develop in underfloor heating and other systems which operate at low temperatures (below 60 °C) as well as open vented systems and those with stagnant or low flow areas.

NOTE 1 Even the high temperature in the appliance heat exchanger might not be sufficient to kill all microorganisms.

NOTE 2 Bacteria, fungi and slimes cause restricted flow and blockages and are liable to foul many parts of the system. Bacteria can thrive in both open vented and sealed systems, especially those fouled with corrosion and other debris, beneath deposits where the temperature might be lower and there is an absence of oxygen. This can give rise to microbiological corrosion of system metals.

6 Treatment of water

6.1 General

COMMENTARY ON ***6.1***

In most cases, the quality of the water used in the central heating/cooling system is determined by supply to the premises and this varies across the United Kingdom.

Water treatment should be applied to all primary systems except for single feed indirect hot water cylinders.

Consideration should be given as to the materials of construction, the operating temperature of the system and to whether the water is hard or naturally soft, as this might influence the approach to water treatment and the choice of proprietary product (refer to the manufacturer's specifications).

A water treatment specialist should be consulted if the incoming water supply to the premises is anything other than municipal mains water, e.g. well water, bore hole water, grey water, to assess suitability.

6.2 External

If a water softener is installed within the premises, all system component (e.g. heating appliance, pump, heat emitters) manufacturers' advice and instructions should be referred to on whether the heating or cooling system may be filled with softened water. If the system is filled with softened water, it should be treated with an appropriate inhibitor suitable for use with softened water, and instructions should be provided detailing the requirement for regular checks and maintenance of the appropriate inhibitor concentration.

1 Last accessed 23 April 2019.

If unsoftened water is to be used, the system should be filled by either:

- using the softener bypass valve which is required for compliance with BS EN 14743; or

NOTE For installation requirements refer to WRAS information and guidance note 9-07-01, "Information for the Installation of Ion Exchange Water Softeners for Systems Supplying Water for Domestic Purposes" [14].

- by a separate, unsoftened supply which is connected upstream of the water softener. In the case of a sealed primary water system this unsoftened supply should feed the filling point of the temporary connection; in the case of an open vented system this should be to the ball valve on the feed and expansion cistern.

6.3 Internal

To minimize the likelihood of corrosion, scale and sludge formation, the water in any system should ultimately be treated with an inhibitor (see Clause **9**). Before the inhibitor is added to the system, the first step should be to render the system in a condition free from foulants.

NOTE 1 Within a new system, contaminants include flux residues, grease, installation debris, metals swarf, solder pieces, stamping oil, welding rod, PTFE tape and plastic pipe swarf and bacterial growth. Within an existing system, contaminants include sludge, corrosion debris, bacterial growth and limescale.

If microbiological fouling is suspected within a system, it should be disinfected by pre-flushing using a disinfectant, formulated specifically for heating and cooling systems.

NOTE 2 Indications of microbiological fouling commonly include the presence of organic slime, a foul odour or restriction of flow. Confirmation of microbiological fouling might be achieved using a laboratory test.

Corrosion inhibitors should not be used as a substitute for correct system design, installation and maintenance.

7 Cleaning

7.1 General considerations

Systems should be cleaned using a chemical product formulated specifically for heating and/or cooling systems.

Before cleaning, the system should be examined to determine the system configuration and the age and overall condition of components, in order to ascertain the cleaning regime required.

NOTE 1 Cleaning is an opportune time to give consideration to the replacement of older and worn parts of the system, e.g. the procedure could remove corrosion debris covering pin-holes in radiators and this could result in leaks.

If there is any doubt as to whether a system will withstand any cleaning methodology, investigation and subsequent replacement or repair of relevant components should be undertaken before continuing.

A choice of cleaning methodologies is available; in most cases involving major work, e.g. commissioning of new systems or boiler change, a system pre-flush (if appropriate), a chemical clean, followed by a fresh water flush and the fitting of a permanent in-line filter should be undertaken, before an inhibitor is applied. For minor work, e.g. change of a circulator pump or individual radiators, it should be noted that it might be sufficient to isolate and change the component without the need to undertake a full system clean. However, such component failures are often as a result of corrosion and the consequential magnetite and other corrosion debris build-up within the system water; where this is the case the system configuration should be checked and any defects likely to be responsible for the corrosion rectified before re-commissioning the system. A full system clean should then be undertaken, and an in-line filter installed (see Clause **8**).

NOTE 2 It is essential that pumped circulation is available throughout the system. A fresh water flush alone, whether hot or cold, is not adequate procedure.

NOTE 3 In-line filter refers to any device that separates and removes circulating solids from the system water.

The cleaner manufacturer's specification and usage instructions should be studied and product selection made accordingly. Unless the manufacturer's instructions state otherwise, products from different manufacturers or different products from the same manufacturer should not be mixed.

Adequate time should be allowed to complete the cleaning procedure.

7.2 Cleaning and flushing methodologies

Cleaning and flushing should be undertaken prior to commissioning a new system and during refurbishment or repair of a system to overcome its loss of effectiveness and efficiency caused by the effects of poor water quality.

NOTE 1 Where a system has been filled for a long period prior to commissioning addition of a biocide, circulation (refer to manufacturer's instructions) followed by a flush might be required in order to remove biofilm.

Cleaning and flushing should be undertaken to remove adherent and settled foulants and debris, and suspended sludge from systems. Where a system is heavily fouled, a pre-flush should be considered prior to the cleaning cycle.

The effectiveness of the cleaning cycle is determined by correct choice and application of the cleaning chemical – a good cleaning chemical should dissolve and/or disperse sludge and contaminants.

NOTE 2 The cleaning cycle time and the water temperature are important factors in achieving a good result. Increasing the velocity and agitation during the cleaning cycle raises the potential for debris removal.

There are three cleaning and flushing options, and appropriate manipulation of the cleaning cycle time and water temperature in each of the methodologies ensures an effective clean of the system prior to flushing; one of the following should be applied:

a) *Powerflushing:* Powerflushing is a cleaning and flushing procedure characterized by using an external pump and tank arrangement to effect the circulation of water or chemical cleaner solution at increased velocity and turbulence through the whole circuit and particularly through individually isolated panel radiators where fitted, such that it reaches the entire inner surfaces of the system with enough force to ensure the cleaning and complete removal of all adherent and settled sludge, foulants and debris.

b) *Mains pressure clean and flush:* Mains pressure cleaning is a cleaning and flushing procedure in which cleaning of the system to remove all adherent and settled foulants and debris relies on an adequate circulation, preferably at operating temperature, of an appropriate chemical cleaner solution followed by a flushing procedure. The flushing procedure is characterized by the flush through of water under mains pressure through the whole circuit and also through individually isolated radiators, such that it reaches the entire inner surfaces of the system for an adequate period to ensure the complete removal of all adherent and settled sludge, foulants and debris.

c) *Clean and flush using gravity (with the assistance of a circulation pump):* Gravity cleaning is a cleaning and flushing procedure in which cleaning of the system to remove all adherent and settled sludge, foulants and debris relies on an adequate circulation, preferably at operating temperature, of an appropriate chemical cleaner solution followed by a flushing procedure. The flushing procedure is characterized by repeated draining and filling the entire system with an adequate total volume of fresh water, such that agitation thereby effected will assist the removal of adherent and settled sludge, foulants and debris.

NOTE 3 The speed and effectiveness of cleaning existing systems, especially those containing a high level of sludge, can be improved by an arrangement for external magnetite capture and/or the mechanical vibration of panel radiators (where fitted). These can be utilized with any of the three cleaning methodologies listed in a) to c).

NOTE 4 Mechanical vibration of a radiator might be effected by simple tapping with a rubber mallet or employment of a device specifically devised for the purpose.

Where possible, reversing the flow should help to remove debris which might otherwise remain trapped.

An appropriate cleaner should be chosen (refer to manufacturers' instructions). The following factors should be taken into account:

1) the reason for cleaning;
2) the system component materials, e.g. aluminium;
3) the age and condition of the system;
4) any specific problems identified; and
5) any local restrictions on disposal of the effluent.

Hot cleaning is more effective than cold cleaning, but the cleaner manufacturer's instructions should be followed.

7.3 Preparation before cleaning

For each of the methods listed above, a number of preparatory steps should be taken:

a) isolate the cold water supply to the central heating system;
b) mark the position or note the settings of lock shield or other regulating valves, then fully open all valves. Remove any thermostatic radiator valve (TRV) heads to ensure maximum flow through the valve;
c) set any diverter or zone valves to their manual, open position;
d) isolating sensitive components should be taken into account, e.g. boiler, fancoil unit – refer to manufacturer's instruction; and
e) in systems where an in-line filter is already installed, it should be cleaned prior to the cleaning cycle.

For powerflushing and mains pressure cleaning of open-vented systems, the feed and expansion cistern should be capped-off or isolated. Any additional open vents should be checked for and capped-off.

For powerflushing, the system component manufacturer's instructions should be checked to establish whether a mechanical method is acceptable, e.g. microbore systems. If it is not acceptable, the component should be isolated so that the system can be flushed separately or an alternative cleaning/ flushing method should be chosen.

NOTE 1 Refer to the equipment manufacturer's instructions for any additional preparation steps.

NOTE 2 If a new boiler is being fitted, to prevent damage or contamination, it is advisable to apply the chosen cleaning/flushing methodology either before the boiler is installed or with the new boiler isolated from the rest of the system.

7.4 Powerflushing

For powerflushing, the equipment manufacturer's recommended operating procedures should be followed. Chemical cleaning is more effective at increased temperature and some equipment allows the boiler to be operated during cleaning, however it should be noted that it might not be possible to elevate the temperature in a cooling water system.

A typical methodology for a radiator system is outlined in a) to g) and should be followed:

a) circulate untreated system water, reversing flow regularly to dislodge settled debris and discharge to foul drain until clear;

b) adjust inlet water to ensure tank water level remains constant during discharge;

c) add cleaner to the pump reservoir and circulate throughout system;

d) use radiator valves to isolate each individual radiator in turn, allowing full flow through each to mobilize and remove contaminants, reversing flow regularly;

e) in reverse sequence, flush each radiator in turn, discharging the water to foul drain until clear;

f) before moving to next radiator, reverse flow until discharge water is again clear; and

g) open all radiators and flush the entire circuit until the water runs clear.

For other heat emitters, this methodology should be adapted accordingly.

Sensitive components that have been bypassed for the flushing and cleaning cycle should be backflushed before they are restored to the circuit, where appropriate, e.g. fancoil units and chilled beams.

7.5 Mains pressure cleaning

For mains pressure cleaning the following steps should be followed:

a) dump system water to foul drain (all radiator and other air vents should be opened to ensure complete removal of system water);

b) dose the system with a cleaner and refill with mains water, bleeding the radiators and any other vent points, where necessary;

c) circulate cleaner in accordance with the manufacturer's instructions before draining the system;

d) connect a mains pressure hose to an appropriate point in the central heating system and a hose from a drain valve to foul drain – a suitable backflow prevention device (see BS EN 1717) should be used when connecting the mains supply to the system;

e) flush each radiator in turn, dumping water to foul drain by isolating the other radiators until the water runs clear; and

f) open all radiators and flush the entire circuit until the water runs clear.

Sensitive components that have been bypassed for the flushing and cleaning cycle should be backflushed before they are restored to the circuit, where appropriate, e.g. fancoil units and chilled beams.

NOTE For high-rise buildings, the mains pressure differential between the bottom and the top of the building might affect the effectiveness of the flush, therefore consideration is to be given to the mains pressure at all locations in the building.

7.6 Gravity cleaning

For gravity cleaning the following steps should be followed:

a) dump system water to foul drain (all radiator and other air vents should be opened to ensure complete removal of system water);

b) dose the system with a cleaner and refill with mains water, bleeding the radiators and any other event points, where necessary;

c) circulate cleaner in accordance with the manufacturer's instructions before draining the system;

d) refill the system, bleeding all radiators and other vent points, where necessary, and circulate the system water before draining the system; and

e) repeat the filling, circulating and draining procedure until the water runs clear.

Sensitive components that have been bypassed for the flushing and cleaning cycle should be backflushed before they are restored to the circuit, where appropriate, e.g. fancoil units and chilled beams.

7.7 Recommissioning

The system configuration and all components should be set to their optimum settings. Where a permanent in-line filter is to be fitted for the first time (see Clause **8**) this should be done immediately after completing one of the cleaning procedures detailed in **7.4**, **7.5** or **7.6**. Chemical inhibitors should be added at the time of final fill with fresh water (refer to the manufacturer's instructions).

In systems where a filter is already installed, it should be serviced as part of the recommissioning process.

Under no circumstances should the system be left empty for extended periods as this could result in the seizing of components or accelerate corrosion of ferrous components, e.g. radiators.

7.8 Special treatments — boiler cleaning as a separate process

In certain circumstances, the heat exchanger might need chemical cleaning as a separate process to remove hard water scale or accumulated corrosion debris; the procedure can involve use of a different chemical to that used for the rest of the system and in such cases, the manufacturer's instructions should be closely followed.

NOTE Attention is drawn to the need to ensure that all cleanser and debris is flushed from the heat exchanger prior to re-introducing system water.

8 In-line filters

*COMMENTARY ON **CLAUSE 8***

In operation, a cleaned and commissioned system might have residual insoluble, suspended particulate debris circulating in the system water.

Circulating particulates have detrimental effects on boilers, pumps and valves.

In order to keep system circuit water free from particulate debris and forestall these consequences, an in-line filter should be permanently installed in the system water circuit to maintain system cleanliness, thereby protecting system components and conserving system efficiency and effectiveness.

In-line filters are devices which capture and remove insoluble particulate matter from the system water using, e.g. magnets, hydrocyclones or porous media through which the system water passes; they should have the facility for periodic removal of captured debris.

Their design and operation should ensure that system water flow is maintained within acceptable parameters. The installation of such devices should follow the manufacturers' instructions.

The installation of an in-line filter or dirt separator does not remove soluble foulants or static debris and it is most important that it should never be regarded as an alternative to system cleaning and flushing as described in **7.2** to **7.6**.

NOTE In-line filter refers to any device that separates and removes circulating solids from the system water.

9 System protection

The corrosion and scale inhibitor used should be suitable for the appliance, system components and water quality and be applied in accordance with the manufacturer's instructions. On application of inhibitor additives, the system water should be circulated long enough to ensure full dispersion and even distribution.

For systems that are not used over the winter months and which might be exposed to very low temperatures, protection from freezing should be taken into account. A suitable inhibited antifreeze product that provides frost protection to the required level, and is suitable for the system components, should be selected and applied in accordance with manufacturer's instructions.

Addition of biocidal products should be taken into account for all systems, especially those that are designed to run at temperatures below 60 °C, to inhibit the formation of microbiological growth and fouling. Products should be selected that are suitable for system components, and applied in accordance with manufacturer's instructions.

10 Testing and ongoing maintenance

The concentration of additives in system water should be checked after commissioning and annually thereafter throughout the life of the system to ensure energy efficiency and the benefits of ongoing protection are maintained. This check should also include an assessment of water cleanliness and servicing of the in-line filter.

Water treatment manufacturers offer laboratory testing services and on-site test kits for this purpose; if necessary, more treatment additives should be added.

To mitigate against potential chemical degradation, corrosion and scale inhibitor should be re-dosed at five-year intervals since last treatment. Alternatively, a full laboratory analysis of the system water should be undertaken to verify ongoing corrosion and scale inhibition. Unless the manufacturer's instructions state otherwise, products from different manufacturers should not be mixed.

Following work on the system where the protection has been significantly diluted or replaced, the inhibitor protection should be checked to ensure that it meets the manufacturer's recommended concentration.

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

BS 5918, *Solar heating systems for domestic hot water – Code of practice for design and installation*

BS 5955-8, *Plastics pipework (thermoplastics materials) – Part 8: Specification for the installation of thermoplastic pipes and associated fittings for use in domestic hot and cold services and heating systems in buildings*

BS EN 14868, *Protection of metallic materials against corrosion – Guidance on the assessment of corrosion likelihood in closed water circulation systems*

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[1] GREAT BRITAIN. Water Supply (Water Fittings) Regulations 1999, SI 1999, No. 1148, London: The Stationery Office.

[2] GREAT BRITAIN. *The Health and Safety at Work, etc. Act.* London: The Stationery Office, 1974.

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[11] NORTHERN IRELAND. The Hazardous Waste Regulations (Northern Ireland) 2005, as amended, SR 2005, No. 300, Belfast: The Stationery Office.

[12] MIS 3005, *Requirements for MCS Contractors undertaking the supply, design, installation, set to work, commissioning and handover of microgeneration heat pump systems – Issue 5.0.*

[13] BSRIA BG 29, *Pre-Commission Cleaning of Pipework Systems.*

[14] WRAS information and guidance note 9-07-01, *Information for the Installation of Ion Exchange Water Softeners for Systems Supplying Water for Domestic Purposes.*

[15] Commission Regulation (EU) No 813/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to eco-design requirements for space heaters and combination heaters.

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