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1. Scope

This document applies to all contracts and facilities within the Healthcare and Education sector. It covers Chemical Water Treatment including initial setup, sampling regime, interpretation of analysis results and chemical dosing of Closed Loop Water Systems.

This standard does not include:

- Pre-Treatment – i.e. Base exchange water softening, de-mineralisation, de-alkalization. Normally the loss of water from a closed loop is low and therefore does not warrant the use of any water pre-treatment.
- Magnetic/electronic water conditioning
- Hot and cold water systems where said water is consumed as a foodstuff or used by persons for washing etc.

This document does not aim to cover all aspects of Closed Loop System Water Treatment, just the key requirements and overall management of the system. Further details information can be found in the reference documents listed at section 5 References.

The assumption of this document is that the contracts are PFI and as such certain provisions are defined by the contractual requirements, however the principles of this document may also be used for non PFI contracts.

2. Equipment Use

Chemical Water Treatment provides the means to control:

- Corrosion
- Microbiological growth

3. Maintenance Objectives

A sampling, analysis and dosing regime to:

- Maintain the water in a closed loop system within specified control values
- Maintain records in order to:
  - Provide sufficient information to satisfy any contractual or warranty requirements
  - Trend the results to give warning of an impending problem.

4. Maintenance Strategy

4.1 Maintenance Condition – Minimum Standard

4.1.1 Base Line Information

The O&M Manuals should include the following details provided by the Specialist employed by the Construction Company:

- Raw Water Analysis
- Materials used in the Closed Loop System
- Chemical Treatment Regime and control values taking account of the above
- Frequency and location of sampling for normal operation

Where the base line information has been provided then it should be acceptable to continue with the regime so long as the on-going analysis does not indicate any abnormal conditions, in which case the principles below where base line information is unavailable should be followed.

Where Base Line Information is unavailable, you should attempt to obtain this from the Construction Company. If however this is not possible then you should seek specialist advice as it is generally not acceptable to rely on the generic recommendations provided by a water treatment company.

A specialist will need to be employed to develop the treatment regime and will need to review the operational and design characteristics of the system. They should be aware of:

- Materials present
- Working temperature and pressure
- Operating volume (from previous testing)
- History of the system (including any pre-commission cleaning activity, any known corrosion problems and remedial works)
- History of the water treatment (programmes and products used)
- A list of extensions/additions to the original system
- Current treatment regime and water sample results

From the above they will be able to recommend a treatment and sampling/analysis regime which should be copied to the water treatment logbook for easy reference. Any sampling and analysis regime must also include guideline control limits where applicable.

For recommendation on Specialist Companies to provide this service contract your Authorising Engineer Mechanical or Authorising Engineer Water

4.2 Sampling

4.2.1 Systems >500 litres.

4.2.1.1 No of Samples and locations

BS 8552 Table 6 provides guidance on the minimum number of samples required and typical locations.

4.2.1.2 Sampling and Analysis Frequency

BS 8552 recommends a maximum of 3 month between routine sampling and analysis.

In addition to routine sampling, sampling and analysis is also required after any of the following – see BS 8552 Table 1 for further details:

- Minor modifications to the system
- Connection of significant system additions
- Significant quantities of water discharged during drain down may require a discharge license and as such samples must be taken and analysed prior to drain down
- Demolition

4.2.2 Systems >100 litres and <500 litres

Sampling frequency is 3 monthly but a reduced testing requirement is recommended – see section 4.3.2.

4.2.3 Systems <100 litres

Such systems are effectively domestic and annual sampling will suffice – see section 4.3.2.

4.3 Sample Analysis

4.3.1 Analysis Service

It is recommended for all systems >500 litres that the analysis of samples is carried out by a laboratory well versed in analysing closed loop water system samples – see Section 4.3.4.

Samples of all types must be delivered to the laboratory within 24hrs of the sample being taken. See BS 8552 section 6.4 for further detail regarding sample storage and transportation.

4.3.2 Systems <500 litres

The recommendation to use a laboratory well versed in analysing closed loop water system samples may be relaxed for systems <500 litres and field testing a limited number of parameters may be more appropriate in terms of cost benefit. The suggested parameters for testing are:

- Microbiology – See Table 2 for control range
- pH – See Table 1 for control range
- Total iron – See Table 1 for control range
- Soluble iron – See Table 1 for control range
- Soluble copper – See Table 1 for control range
- Corrosion Inhibitor – See Table 1 for control range

These tests could be done by site test kits which would avoid the need for laboratory costs. Bacteria levels can be measured by ATP test kit which give an instant reading.

> Field testing i.e. a test kit or instrument for use at site that measures the required parameters can be used to analyse the water chemistry. It is cheaper than laboratory testing, but less accurate.

4.3.3 Parameters

The following table taken from BSRIA Guide BG50 represents the range of tests that may be required during the operational phase of a closed loop system i.e. after commissioning and handover.

It is unlikely that all parameters will be required, but it is also conceivable that additional microbiological parameters not listed may in some circumstances also be required as there are numerous other species of bacteria and fungi that can be found within a closed system. Such additional parameter will only be required in extenuating circumstances and only on the recommendation of a specialist.

The notes column refers to additional information available in the BG50 document and the notes have not been repeated in this document. If you wish to review the additional information, then BG50 can be downloaded using the IHS service.

The “notes” referred to above also contain in some cases guidance on acceptable limits or ranges for the specified parameter. However, for every instance of “Within Specified

Range" and "Limit as Specified" in Table 1 and Table 2 it is for the Water Treatment Specialist to advise on suitable control values. You can check their advice by referring to the notes and if still unsure then seek guidance as per section 4.8.3.

4.3.3.1 Table 1 – Chemical Parameters

Group	Parameter	Guideline	Note
Physical condition	Visual appearance (suspended/settled solids)	Clear with no visible suspended solids or gassing	1
	Odour	No strong sulphurous or ammoniacal smell	2
	pH	Within specified range	3
	Conductivity and total dissolved solids (TDS)	Within specified range	4
	Suspended solids	Limit as specified for the circulating water. No increasing trend	5
	Settled solids (as defined in BG 29[1] & BS 8552[6])	Limits as specified for pipework at the extremes of the systems and for terminal units	6
Water treatment status[1]	Nitrite (where used)	Within specified range	7
	Nitrate	Within specified range	8
	Molybdate (where used)	Within specified range	9
	Boron	Within specified range	10
	Phosphonate	Within specified range	11
	Organic inhibitors	See note	12
	Silicate	Within specified range	13
	Orthophosphate	Within specified range	14
Hardness	Total alkalinity	For information	15
	Calcium hardness	For information	16
	Total hardness	For information	17
	Total iron	Limit as specified	18

Group	Parameter	Guideline	Note
Corrosion products	Dissolved iron	Limit as specified	19
	Copper	Limit as specified No increasing trend	20
	Zinc	Limit as specified No increasing trend	21
	Aluminium	Limit as specified No increasing trend	22
Other	Sulfate	>90% of fill water sulphate No decreasing trend	23
	Chloride	Limit as specified	24
	Ammonia	Limit as specified	25
	Dissolved oxygen	For information	26

4.3.3.2 Table 2 – Microbiological Parameters

Microbiology	Total viable count (TVC)	Limit as specified No increasing trend	27
	Pseudomonads	Limit as specified No increasing trend	28
	Sulfate reducing bacteria(SRB)	Not detected	29
	Nitrite reducing bacteria (NRB)	For information	30

The minimum parameters to test for are shaded .

[1] In addition. In the table section “Water treatment status” you should test for presence of the chemicals recommended in the Water Treatment Regime.

4.3.4 Accreditation

There is no accreditation service (e.g. UKAS) available for laboratories providing microbiological and chemical analysis of water from closed loop systems. Therefore, you must ensure the laboratory you use are familiar with the standards and tests within BS8552, specifically Table B.1 which details all the required tests and analytical methods.

The Laboratory must be able to undertake the sampling using the analytical methods described in Table B.1 of BS8552 and for the avoidance of doubt a copy Table B.1 of BS8552 should be sent to the laboratory with a request to confirm they are able to comply with the requirements of said table.

Laboratories may also know these tests as 'BSRIA' samples.

Whilst none of the above guarantees accuracy of results, it does show that we as a business have acted with due diligence and gives some assurance that the laboratory:

- Is technically competent to do the work in question
- Performs to the required standard for each analytical method required

4.4 Raw Water Supply

Use only water from the mains supply to fill and top up closed loop systems.

Water from other sources e.g. rainwater harvesting etc should never be used without expert advice due to the heavy bacterial contamination in such sources of water.

4.5 Loss of Water

The expectation for water loss from a closed loop system is low, therefore if losses equate to more than 5% per year then there is something wrong which must be corrected as soon as reasonably practical.

Any losses from leaks, weeping seals, glands etc. will result in fresh water entering the system. Unless pre-treated, incoming mains water can be almost fully saturated with dissolved oxygen. Dissolved Oxygen is a major cause of corrosion in closed loop systems. The chemical treatment in the system can cope with small amounts of make-up water which from normal losses is in the region of 5% of system volume per year. Regular testing allows for additional chemicals to be added as levels drop due to dilution from make-up water, thus maintaining an equilibrium and controlling corrosion and microbiology.

Large losses e.g. drain downs for maintenance etc. or sustained excessive leakage will result in significant dilution of the treatment chemicals which will unless quickly corrected result in corrosion and bacterial growth.

Whilst monitoring dissolved oxygen levels will give an indication of losses, the recommended minimum frequency of sample and analysis is 3 monthly and within this time period the dissolved oxygen in make-up water can corrode through the pipe walls, particularly in the case of thin wall carbon steel pipe, therefore the only sensible approach to monitoring system losses is by water meter.

4.6 Water Meter

Any system in excess of 100 litres must be fitted with a water meter. The only exception to this would be systems where all pipework is clearly visible and any leaks immediately apparent. However, in addition to indicating water loss, a water meter also quantifies the loss which helps to gauge the amount of chemical make-up required. Take this into consideration when deciding whether or not to install a water meter in systems where all pipework is clearly visible.

A water meter should be installed on the incoming water supply to the pressurisation unit. Ideally the water meter would be linked to the BMS to provide constant monitoring and alarm where the measured loss would equate to in excess of 5% of system volume per year. Where this is not feasible then the water meter should be read and logged at least weekly but ideally daily.

4.7 At Risk Systems

All closed loop systems both hot and cold are at risk of corrosion and biofouling unless managed appropriately, but in particular the following systems can very quickly suffer problems:

- Thin wall carbon steel pipework – wall thickness is only 1 to 2mm
- Boilers with aluminium heat exchangers – susceptible to high pH levels
- Under floor heating – operates at temperatures ideal for microbiological growth

4.8 Records

Records are an essential part of Water Treatment because they:

- Provide evidence of compliance which is vital in cases of defence and warranty claims
- Properly structured and monitored they can provide warning of problems in Closed Loop Systems before serious damage occurs

The key records to maintain are:

- The initial treatment regime as provided by the specialist employed by the Construction Company
- Any changes to the treatment regime and on whose recommendation
- Details of treatment chemicals used at and since commissioning
- Water chemistry analysis reports
- Water microbiology reports
- The specification for the services of the Water Treatment Specialist
- Changes to the Water Treatment Specialist
- Volume of each system
- Materials used in each system e.g. steel, aluminium, copper etc
- All historical records when taking on an existing system. Where these are not available then you must arrange for an appropriate number of samples and analysis of the full suite of BSRIA BG50 parameters. Where specialist advice is required for interpretation of results then refer to Section 4.8.3
- Any additions to the system including the pre-commissioning cleaning records and treatment records or treatment topping up records where there is no hydraulic separation

4.8.1 Reports

The water treatment specialist must provide a report at each and every visit whether it be a routine regular visit to take samples or a one-off visit for a specific problem. The routine visits will be for water sampling, so there will be a delay before the full analysis report is received, however they should be encouraged to report any issues from the visual and odour parameters immediately after the sample has been taken.

The chemical analysis report should be received within 7 days after receipt at the laboratory

4.8.2 Trending

To enable trending, unless this is a service offered by the Water Treatment Specialist it will need the parameter values transferred to a spreadsheet and then charts produced complete with trend lines.

Trending allows interpretation of results that can give early warning of problems but may need a level of ability not available locally in which case refer to the Specialist Remote Support Service at Section 4.8.3

Ideally the Water Treatment Specialist commissioned for the Closed Loop Sampling and Analysis will transfer all the results data to a system that can trend the data. This is likely to be an on-line service and you should ensure that:

- Engie have full access to the data
- Ensure sufficient training is given to all staff using the system
- Data must be retrievable over any time scale
- There must be a system in place to ensure ENGIE have access to the data information for a minimum of 5 years or longer depending on contractual requirements for document retention
- If the Water Treatment Specialist is replaced by another, ensure that safeguards are in place to ensure the data is handed over in a legible format

In the absence of the Water Treatment Specialist having a system for data logging and trending, an Engie spreadsheet is available. Contact your AE Mechanical or AE Water who can provide guidance on how to use the spreadsheet and the location of the current version.

4.8.3 Acting on results and Specialist Advice

It is vital that somebody within the contract team takes responsibility for reviewing the analysis results and acting on any recommendations made by the Water Treatment Specialist.

If any of the recommendations are unusual or seem wrong then specialist advice can be sought from the ‘free’ ENGIE Remote Support Service for ‘closed loop systems’ provided by Parsloe Simpson.

The contact details for Parlsoe Simpson are shown below. However, as this is being provided as a free service, we would like to filter the calls so that only those that need specialist advice go to Parsloe Simpson. So, in the first instance please make contact with Reece Humphreys on 07740 924 614 email Reece.Humphreys@engie.com who will pass the enquiry on as appropriate:

Dr Pam Simpson - Mobile: 07771 788048
Chris Parsloe - Mobile: 07929 956379
Email - info@parsloe-simpson.co.uk
Office Tel No - 01983 756783

4.9 System Modifications

It is inevitable over time systems will require upgrading, extended or modifying in some way to increase user comfort or meet changing demands on services. As such

modifications are requested, the existing closed loop system is quite often missed, but must be reviewed and form part of the design process.

4.9.1 Design Considerations

The following must be considered

i. Are the piping material, appliances and/or components compatible with the present water treatment regime.
ii. If this needs to be altered, will this have an effect on your current pipework, boilers or chillers etc.
iii. Breaking-in and service Isolations need to be carefully considered. Isolation valves may be some distance from the break-in point; which could lead to draining long lengths of pipework, wasting your expensive water treatment chemicals and leave long lengths of wet pipework filled with air; which is an ideal combination for bacterial growth and corrosion This will challenge your water treatment when brought back into service.
iv. When isolating the existing system, long dead-legs of non-circulating water should be avoided whenever possible. Where this is not practical then:

- Consider 'live' line-stopping; which is a specialist service where holes are drilled in the pipe introduce a "plug" to temporarily stop the flow in an operating pipe. Line stopping can be used to isolate piping systems for repairs, alteration, or relocations. If used in conjunction with bypass lines, product flow can be continued around the isolated section of pipe to be repaired. Additional valves can be inserted at this time with no need to switch off or drain down the system
- For any systems that have a history of corrosion or bacterial issues; this would be paramount.

4.9.2 System Cleanliness

i. Any new extensions to any closed loop systems must receive a pre-commissioning pre-clean, clean and flush as recommended by the manufacturers and as stated within BSRIA Pre-Commission Cleaning of Pipework Systems BG 29/2012.
ii. Filling the system from anything other than water from the water supplier's main e.g. bore holes, brook etc. must not be considered without specialist advice.
iii. Any existing system that is known to be in a poor condition from either historical corrosion or bacterial issues resulting in a high content of particulate matter and/or bacteria must have hydraulic separation between the existing and new system; ensuring such contamination does not crossover to the new system.

NOTE:

Where thin-wall carbon-steel is the pipework material of the existing or proposed for the new system; hydraulic separation is the preferred option as any alteration to the system, even introducing fresh water can have a detrimental effect on the existing system. This would clearly be dependent on the size of the extension and the condition of the existing system. Any doubts obtain specialist advice from the 'free' ENGIE Remote Support Service for 'closed loop systems' provided by Parsloe Simpson – See Section 4.8.3

4.10 Asset Structure

NA

4.11 Record Keeping

Records of maintenance activities must be kept for a minimum of 7 years or as dictated by contract conditions.

5. References

- BG 29/2012 – BSRIA: Pre-Commission Cleaning of Pipework Systems
- BG 50/2013 – BSRIA: Water Treatment for Closed Heating and Cooling Systems
- BS 8552 – 2012 Sampling and Monitoring of water from building services closed systems