**Introduction**

Water treatment has been described as White Magic but it only becomes White Magic if you let it happen or if a Water Treatment supplier leads you to believe it is so. After working in the Water Treatment Industry for many years I decided to try to simplify some of the issues relating to water treatment. This outline of water treatment for various types of systems is designed to give the reader an idea of the risks from impurities that are present in various types of waters. It is also designed to show that the risks vary from system to system and to help users and operators to better understand the type of treatments and services that are available to eliminate or minimise these risks.

It is not meant to be an all encompassing guide for every scenario and this is where the expertise and the experience of a professional Water Treatment Company comes in. It is however designed to help the reader to check that the proposals being submitted will not only protect their systems but will help you to ensure that the proposals are designed to help customers to reduce energy and water throughout their facilities whilst minimising both health and environmental risks for each site. As an industry we have a duty to use water treatment to help our customers to reduce scarce resources on this planet.

We also have a duty to recommend environmentally friendly products such as Sanosil® water and surface disinfectants which break down to water and oxygen and products such Green Smart Release Technology® solid chemicals for cooling tower protection. Our guidelines are called “Simplifying Water Treatment the AquaChem Way”. We have updated these guidelines as products and services change and will continue to do so.

We hope you find these guidelines of help and would welcome any suggestions that our readers may have for improvement.

Kieran J Coleman
Technical Marketing Director
General Causes of Corrosion and Fouling in Heating and Chilled Water Systems

◊ Quality of make-up water e.g. low hardness and low alkalinity increases the risk of corrosion
◊ Low pH also increases risk
◊ High level of solids increases risk of erosion damage
◊ High chloride increases risk of corrosion especially on stainless steel
◊ Surface deposits due to insufficient pre-cleaning or on-going corrosion problems
◊ Oxygen ingress especially at pumps
◊ Welds
◊ Proximity of dissimilar metals
◊ Breakdown of corrosion inhibitor film due to low or varying treatment levels
◊ Low flow areas
◊ High flow rates which can strip off inhibitor film
◊ Presence of biological contaminants such as bacteria and fungi which can cause problems especially in the case of chilled water systems and heating systems that are used intermittently
◊ Use of antifreeze such as mono ethylene or propylene glycol on chilled systems while offering protection from freezing will actually encourage the growth of fungi and bacteria under which corrosion can occur even if correct levels of inhibitors are maintained in the systems.
System Design and Operation to Minimise Corrosion Risks

◊ Use metals with lowest risk of galvanic corrosion where costs allow
◊ Use seals and gaskets from materials which do not corrode such as plastic and rubber
◊ Ensure that seals and gaskets are suitable for the temperatures of the systems
◊ Ensure that you use seals and gaskets that are not affected by water treatment chemicals
◊ Re-circulation pumps should be designed to give flow rates of at least 1 metre/second to reduce the risk of corrosion inhibitor film breakdown
◊ Minimise dead legs and low flow areas plus alternate system pumps at least weekly
◊ Pre-clean each system using proprietary chemical blends which also have an in-built inhibitor such as ChemSperse 105
◊ Pre-cleaning to be carried out in line with Method Statements which fully comply with BSRIA Guidelines for Pre-commission Cleaning of new systems
◊ Immediately systems are pre-cleaned add recommended quantity of multi-metal corrosion inhibitors such as ChemHib 101, 201, 301 or 401
◊ Use a biocide such as AquaKill on all chilled and heating systems to control microbial growth. Confirm that each system has a low level of microbial contamination using ATP measurement – control to be less than 50 RLU’s
◊ Ensure that a water treatment company provides certification to confirm that all pre-cleaning has been carried out in line with BSRIA guidelines and that corrects levels of corrosion inhibitors plus biocides have been added to the systems
◊ Method of top-up dosing can be automatic using the ChemTech 2000 system or semi-automatic depending on site requirements. Automatic is first choice because it maintains correct levels of corrosion inhibitors at all times
◊ Simple on-site testing for inhibitor levels to be carried out at least once/month with independent testing by water treatment company each quarter

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◊ Water Treatment Company to test each system at least quarterly with the following minimum analyses on each system:
  ▪ inhibitor levels
  ▪ iron
  ▪ conductivity
  ▪ pH
  ▪ bacteria levels.

◊ In addition tests for Aluminium and Copper should be carried out on systems which contain these metals. For systems containing Aluminium a pH control range of 6.5 to 8.5 maximum must be maintained using corrosion inhibitors such as ChemHib 201 or 301 which have specific in-built Aluminium inhibitors.

◊ Corrosion coupons of system metals can be used especially on high risk systems to provide regular monitoring of corrosion rates with a target of 2 to 5 mils/year for iron which is generally the metal which gives most problems

◊ Schedule regular system inspections

◊ Paint metal make-up tanks with protective paints which are suitable for the temperatures involved

◊ Where parts of the system have to be replaced or extended make sure that the new sections are pre-cleaned before linking in to the existing system

◊ Fit water meters or ensure that Water Treatment Company advises on high system losses which will be indicated by high chemical usage

◊ Modify/repair system leaks to maintain losses below 0.5% of system volume/week.

**General Causes of Scale on Heating Systems**

◊ Quality of make-up water - high hardness greatest risk

◊ High pH increases risk

◊ Higher levels of solids
Temperature of system operation
High water losses of greater than 0.5% of system volume/week

System Design and Operation to Minimise Scale Build-up

- Examine option of pre-treatment such as softening or reverse osmosis for high hardness waters
- Reduce water losses to less than 0.5% of volume/week
- Pre-clean each system using proprietary chemical blends which contain polymers/dispersants such as ChemSperse 105 with work being carried out in line with Method Statement which complies with BSRIA guidelines
- Immediately systems are pre-cleaned use inhibitors which contain olymers/dispersants such as ChemHib 201 or ChemHib 301 which help keep hardness in suspension
- If hardness of make-up water is greater than 60 mg/l consider the installation of a water softener
- Ensure that a water treatment company provides full certification to confirm that all pre-cleaning and inhibition has been carried out in line with BSRIA guidelines
- Method of dosing can be automatic or semi-automatic depending on site Requirements. First choice is a fully automatic monitoring and control system such as ChemTech 2000 system which improves system protection
- Simple on-site testing to be carried out at least once/month
- Water Treatment Company to test each system at least quarterly with the following minimum analyses on each system:
  - Check that pre-treatment plant is operating to target results
  - Inhibitor levels
  - Conductivity
  - pH
  - Hardness levels
◊ Schedule regular system inspections
◊ Fit a water meter to check system losses
◊ Modify system to eliminate system losses

**General Causes of Corrosion, Scale and Fouling on Open Re-circulating Cooling Systems.**

**Causes of Corrosion**

◊ Quality of make-up water - low hardness and low alkalinity waters result in increased corrosion risks
◊ Pre-treatment such as softening while it reduces the risk of scale build-up it increases the risk of corrosion
◊ Low pH increases risk
◊ High chloride in water increases risk especially on stainless steel
◊ High bacteria levels can result in under deposit corrosion even when correct levels of inhibitor are maintained in a system
◊ High levels of suspended solids can also result in under deposit corrosion
◊ Proximity of dissimilar metals i.e. copper and mild steel
◊ Low or no flow areas in parts of systems that are idle
◊ Breakdown of corrosion inhibitor film due to varying or low treatment levels
◊ High flow rates which can strip off inhibitor film
◊ Temperature of system operates which can encourage microbial growth
System Design and Operation to Minimise Corrosion

◊ Carry out full analyses of make-up water
◊ Ensure that system operates within recommended pH ranges
  - 8.5 maximum recommended for galvanised systems
◊ Control bacteria levels at a maximum of 50 Relative Light Units (RLU’s) (as measured instantly by the Lumitester PD20 ATP/AMP meter) or $10^4$ organisms/ml as measured by dipslides which take up to three days to grow.
◊ Use biocides such as the BioChem range of biodegradable biocides to achieve this control
◊ Minimise or eliminate dead legs and low flow areas
◊ Use metals with lowest risk of galvanic corrosion where costs allow
◊ Pre-clean each system using proprietary chemical blends which have in-built corrosion inhibitors such as ChemSperse 105
◊ Immediately systems are pre-cleaned add recommended quantity of corrosion inhibitors such as PolyChem C1033EV, C403, C503 or C903
◊ Ensure that a Water Treatment or Pre-cleaning Company certifies that all pre-cleaning and initial inhibitor dosing has been carried out in line with BSRIA guidelines
◊ Liaise with a competent Water Treatment Company to design easy to operate and maintain automatic dosing and bleed-off systems
◊ In order to comply with International guidelines on-site testing should be carried out at least once/week covering the following minimum analyses:
  ▪ inhibitor levels
  ▪ conductivity
  ▪ bacteria levels
◊ Weekly on-site checks should also be carried out on the following
  ▪ conductivity bleed-off system to make sure that it is working correctly
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- dosing pumps if they are being used
- Water Treatment Company to test each system including the make-up water at an agreed frequency (guidelines say test should be carried out monthly) with the following minimum analyses on each system:
  - inhibitor levels (tower system only)
  - iron
  - conductivity
  - pH
  - calcium hardness
  - alkalinity levels
  - Total levels of micro organisms in the system which should be less than 50 Relative Light Units (RLU’s) (as measured instantly by the Lumitester PD20 ATP/AMP meter) or $10^4$ organisms/ml as measured by dipslides (a three to four day test).

◊ Eliminate dead legs and low flow areas around the systems
◊ Corrosion coupons containing system metals should be used to provide regular monitoring of system corrosion rates with a target of 2 to 5 mils/year for Iron which is generally the metal which gives most problems
◊ Schedule annual system inspections
◊ Where parts of the system have to be replaced or extended ensure that the newly added sections are pre-commission cleaned
◊ Ensure that a Water Treatment Company advises on how to minimise water, energy and chemical usage
◊ Ensure that system operates at the maximum safe concentration factor to reduce water and chemical usage
◊ Keep a record of water usage
**Causes of Scale on Open Re-circulating Cooling Systems**

◊ Quality of make-up water - high hardness and high alkalinity waters increase scaling risks
◊ High pH increases risk
◊ High system operating temperatures even on medium hardness waters, 50 to 100 mg/l in the make-up, lead to increased scaling risks
◊ Low or no flow areas especially in high temperature areas
◊ High levels of solids especially in high temperature areas

**System Design and Operation to Minimise Scale Build-up**

◊ Carry out full analyses of make-up water
◊ Examine option of pre-treatment such as softening for higher hardness waters and for medium hardness waters where system operates at high temperatures
◊ Re-circulation pumps should be designed to give flow rates as near to 1 metre/second as possible
◊ Minimise low flow areas and eliminate dead legs
◊ Pre-clean each system using proprietary chemical blends such as ChemSperse 105 which contain polymers/dispersants
◊ Immediately systems are pre-cleaned use inhibitors which also contain polymers/dispersants such as PolyChem C1033EV, C403, C103 and C903
◊ Ensure that a water treatment or pre-cleaning company provides full certification that all pre-cleaning and inhibition has been carried out in line with BSRIA guidelines
◊ Liaise with a competent water treatment company to design an automatic dosing and bleed-off system which is easy to operate and maintain
◊ In order to comply with International guidelines on-site testing should be carried out at
least once/week covering the following minimum analyses:
- inhibitor levels
- conductivity
- bacteria levels

◊ Weekly on-site checks should also be carried out on the following
- conductivity bleed-off system to make sure that it is working correctly
- dosing pumps if they are being used

◊ Water Treatment Company to test each system including the make-up water at an agreed frequency (guidelines say test should be carried out monthly) with the following minimum analyses on each system:
- inhibitor levels (tower system only)
- iron
- conductivity
- pH
- calcium hardness
- calcium hardness balance between tower water make-up and tower water itself to show that scale build-up is not happening. See enclosed Addendum which shows the increased energy costs of even small levels of scale on cooling towers or evaporative condensers
- alkalinity levels
- Total levels of micro organisms in the system which should be less than 50 Relative Light Units (RLU’s) (as measured instantly by the Lumitester PD20 ATP/AMP meter) or $10^4$ organisms/ml as measured by dipslides (a three to four day test).

◊ Schedule regular system inspections

◊ Ensure that Water Treatment Company advise on how to minimise water, energy and chemical usage

◊ Record water usage
Causes of Fouling on Re-circulating Cooling Systems

Biological Fouling

◊ Quality of make-up water e.g. high bacterial, fungal or algae levels increase potential for biological fouling
◊ Temperature which encourages growth of certain organisms such as the Legionella bacteria which grow mainly between 20°C and 47°C but can survive up to near 60°C
◊ Certain types of gaskets, seals, coating and jointing materials can encourage growth
◊ Chemical inhibitors which contain products such as high Nitrites and can also encourage growth
◊ Sunlight, especially, encourages algae
◊ Distance from exhaust air outlets
◊ Presence of high levels of inorganic impurities
◊ Presence of oxygen and carbon dioxide
◊ System pH’s of 6.5 to 8.5, which most cooling systems operate within, is ideally suitable for bacterial growth
◊ Water flow rates affect growth rates as low flow rates encourage growth

System Design and Operation to Minimise Biological Fouling

◊ Ensure that make-up water contains low levels of micro-organisms
◊ Use a pre-treatment system, if required, to reduce levels of organic and inorganic impurities
◊ Use seals, gaskets and jointing materials which do not encourage growth of organisms
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◊ Ensure that the scale and/or corrosion inhibitors used to treat the system do not encourage growth of micro-organisms

◊ Use cooling systems which minimise the amount of sunlight that comes in contact with the system water

◊ Ensure that systems are kept as far away as possible from sources of contamination including exhaust air outlets

◊ Eliminate deadlegs and ensure that system flow rates are near to 1 metre/second

◊ Use the services of a competent water treatment company to design a biocide dosing system which will automatically and accurately dose biocides.

◊ For new systems make sure that they are pre-cleaned using a biocide such as Sanosil to get rid of any microbial contamination that is present in the water

◊ Immediately the system is pre-cleaned ensure that it is dosed with the recommended quantity of biocides such as from the BioChem or Sanosil range

◊ Ensure that a water treatment or chemical cleaning company provides certification that all pre-cleaning and inhibitor dosing has been carried out in line with BSRIA guidelines

◊ On-site biological testing should be carried out at least once/week with total levels of microorganisms in the system being less than 50 Relative Light Units (RLU’s) (as measured instantly by the Lumitester PD20 ATP/AMP meter) or $10^4$ organisms/ml as measured by dipslides (a three to four day test).

◊ Water treatment company must also check bacteria levels and advise on changes required to biocide dosing regime should bacterial counts show an upward trend

◊ Inspection systems regularly at least quarterly

◊ Maintain system conductivity as high as possible as this will reduce water and keep biocides in the system for as long as possible thereby increasing their effectiveness rate

◊ Biocide dosing system should have a lock out timer to prevent bleed-off of system water for up to six hours after biocide dosing to increase the kill rates for micro-organisms

◊ Ensure that the Water Treatment Company advises on how to minimise water usage.

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General Fouling of Re-circulating Cooling Systems

Causes of General Fouling

◊ Quality of make-up water e.g. if water contains high levels of suspended matter such as dust, silt or clay it increases the potential for fouling
◊ Location of the plant
◊ Biological matter such as pollen and insects
◊ Contamination from the process being cooled
◊ Oil, grease and jointing compounds
◊ Deadlegs and low flow areas

System Design and Operation to Minimise General Fouling

◊ Locate cooling systems in areas less prone to airborne contaminants
◊ Consider use of pre-filters where make-up water containing high suspended matter has to be used
◊ Alternatively use automatic side-stream filters (which only require 5% of re-circulating water to go through them) to remove suspended matter from re-circulating water
◊ Design/re-design system to minimise process contamination
◊ Eliminate deadlegs and low flow areas
◊ Design system to have flow rates of 1 metre/second
◊ Minimise amount of grease and jointing compounds
◊ Use inhibitors such the PolyChem C range which contain antifoulants or dispersants to assistant in keeping general fouling contaminants in suspension until removed during bleed-off.
Assessing and Minimising the Risks of Legionnaires Disease on New and Existing Systems

General Conditions in which Legionella Bacteria Grow and Cause a Health Risk

◊ Water temperatures between 20°C to 47°C
◊ pH levels of 6.0 to 9.0
◊ Presence of other bacteria
◊ Presence of other deposits such as scale
◊ Presence of iron
◊ Presence of nitrogen compounds
◊ Ability of system to produce aerosols (water droplets) such as those produced by cooling towers, spray taps, misters, pressure washers, ornamental, safety and domestic showers.
◊ Deadlegs and low flow areas

Assessing and Minimising the Risks

New Systems

◊ Carry out full water analyses of make-up water
◊ Design system to minimise risks such as ensuring Cooling Towers contain efficient Drift Eliminators to minimise aerosol production
◊ Water tanks should be designed to prevent contamination
◊ Calorifiers should be designed to heat water to 60°C without stratification
◊ Tanks and hot water heaters should be accessible for cleaning and draining
◊ Ensure systems are pre-chlorinated to a set standard such as BS 6700:1 for New or
Refurbished Buildings
◊ Ensure that the Water Treatment Company or whoever carries out the pre-chlorination carries out this work in line with BS 6700 or equivalent standard
◊ Ensure that each system is immediately treated with a full programme to prevent scale, corrosion and control bacteria levels within maximum recommended limits for each system
◊ Cooling towers to have weekly on-site testing
◊ Weekly, Monthly, Quarterly, Six Monthly and Annual checks to minimise the risk of Legionnaires Disease plus actions required are detailed in Addendum 2 at the end of these guidelines
◊ Maintain records of all tests and corrective actions carried out
◊ Water Treatment company to carry out independent tests on each system at agreed frequencies - for cooling towers this should be monthly
◊ Carry out system cleaning and disinfection every six months on cooling towers and once per year on all other systems which operate within the temperature range of 20°C to 47°C.
◊ Cleaning and disinfection work to be carried out in line with a Method Statement which complies with Irish HPSC National Guidelines for the Control of Legionellosis in Ireland, 2009 or UK L8 Guidelines
◊ All Cleaning and Disinfection work to be certified
◊ Carry out Legionella tests on cooling towers each quarter and on all other systems every six months.

Existing Systems
◊ Full water analyses of both make-up and system waters
◊ By law you must carry out a full Risk Assessment to comply with Irish Safety, Health and Welfare at Work at 2005 and/or with Irish HPSC National Guidelines for the

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Control of Legionellosis in Ireland, 2009, UK L8 Guidelines or the equivalent in other countries. This will involve areas such as system inspections, checks on water testing records, cleaning, maintenance, dosing and control systems, temperature measurements and operation of pre-treatment systems together with information on system volumes and location. Type of calorifiers and any evidence of temperature stratification should also be examined. Based on the Risk Assessment a full report will be prepared detailing weekly, monthly, quarterly, six monthly and annual procedures required to minimise the risks for each system

◊ Layout drawings also need to be completed as part of Risk Assessment.
◊ Complete treatment programme needs to be in place to minimise biological growth, scale and corrosion
◊ Chemical dosing (and bleed-off in the case of re-circulating cooling systems) needs to be carried out automatically to ensure safety, accuracy and consistency
◊ Regular on-site testing with results recorded and action taken documented at least weekly in the case of cooling towers/evaporative condensers
◊ Full on-site independent tests by Water Treatment Company for scale, corrosion prevention and control of microbiological growth with corrective action fully documented
◊ System Cleaning and Disinfection every 6 months for cooling towers and annually for all other systems or where inspection shows evidence of build-up of deposits in water tanks or fountains
◊ All Cleaning and disinfection work to be carried out in line with a Method Statement which complies with Irish and UK guidelines
◊ Legionella tests each quarter on cooling towers and every six months from all other water systems which pose a risk
General Causes of Scale on Steam Systems

◊ Hardness in make-up water
◊ High alkalinity and dissolved solids
◊ High pH

System Design and Operation to Minimise Scale

◊ Pre-treatment of make-up water using Base-exchange softeners if hardness removal only required. Use Reverse Osmosis (RO) if make-up water contains high alkalinity and high dissolved solids. R.O. treated systems minimise blowdown and chemical usage.
◊ Ensure that boilers are pre-cleaned using proprietary cleaners such as AquaChem C32
◊ Immediately systems are pre-cleaned use full water treatment programme
◊ Ensure that a water treatment company provides full certification that all pre-cleaning and inhibition has been satisfactorily carried out
◊ Use supplementary treatment to prevent treated feedwater from forming scale or sludge
◊ Design or modify steam system to maximise condensate return which
  - reduces risk of scale
  - reduces blowdown and energy usage
  - reduces chemical usage
◊ Use automatic dosing and blowdown systems to control chemical dosage and blowdown in line with steam usage
◊ Control boiler Total Dissolved Solids (TDS) at maximum level recommended by manufacturers to save water, energy, chemicals and salt
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◊ Regular on site tests for
  - Alkalinity
  - Phosphate/sludge conditioner
  - Total Dissolved Solids
  - Feedwater hardness and pH
  - Pre-treatment plant hardness or conductivity

◊ Water Treatment Company to test each system at an agreed frequency for the following minimum analyses
  ▪ Alkalinites
  ▪ Phosphate/sludge conditioner
  ▪ Levels of oxygen scavenger
  ▪ Total Dissolved Solids (TDS)
  ▪ Feedwater hardness, TDS, iron and pH
  ▪ Condensate pH, TDS and iron
  ▪ Pre-treatment plant hardness or conductivity
  ▪ Raw water make-up hardness, pH and conductivity

◊ Schedule annual system inspections with full reports and recommendations at the end of each inspection

◊ Ensure that the water treatment company advises on how to minimise water, energy and chemical usage

**General Causes of Corrosion on Steam Systems**

◊ Use of artificially softened or reverse osmosis treated water as make-up
◊ Alkalinity levels - high alkalinity levels generate high carbon dioxide which condenses to give carbonic acid in condensate lines - low alkalinity levels give low system pH also causing corrosion
◊ Feedwater temperature - low temperature means higher oxygen which if untreated can result in pitting corrosion
◊ Feed tank design
◊ Insufficient or incorrect system pre-cleaning

**System Design and Operation to Minimise Corrosion**

◊ First choice is to fit a de-aerator which virtually eliminates all oxygen from the water that is fed to boilers
◊ Where de-aerators are not in place ensure that systems which use feed tanks are designed so as to give good mixing of condensate and pre-treated make-up water. Condensate to be fed into feed tank at two thirds of the way down and sparged to ensure good mixing
◊ Water supply to boiler from feed system to be at opposite end to the supply of cold water to the feed tank
◊ Where de-aerators are used oxygen scavengers dosage to be to de-aerator sump
◊ Where feed tanks are used oxygen scavengers dosing to be direct to feed tank at a point of good circulation well below the water low line. This will give the chemical time to remove the oxygen before it gets to the boiler. It will also help to protect the feed tank and feed lines
◊ Alkalinity treatment where required should also be dosed to the feed tank to give correct pH for protection of feed tank and feed line - ideally at least pH of 7.5 to 8.5 and up to 9.5 where high alkalinity waters and/or long condensate lines are in place
◊ **Reverse Osmosis** systems should be considered for high alkalinity waters to remove alkalinity and reduce solids levels which in turn reduces blowdown and save on water, energy and chemicals. For medium to larger steam systems reverse osmosis systems can pay for themselves in months rather than years
◊ Maintain feed temperature as high as possible by lagging, maximising condensate
return and proper mixing of condensate and treated make-up. **Note that water at** 70° C has 77% more oxygen than water at 85° C. Maintaining high feedwater temperatures will:

- Reduce risk of oxygen corrosion
- Reduce amount of chemical treatment required
- Reduce the amount of blowdown if oxygen scavengers such as catalysed sulphite are used

◊ Consider alternative zero solids oxygen scavengers such as OxyChem 1602 which contains catalysed DEHA

◊ Ensure correct pre-cleaning with proprietary cleaners/boilout chemicals such as AquaChem C32

◊ Immediately systems are pre-cleaned use full boiler water treatment programme to protect the complete steam system of de-aerator or feedtank, condensate system and the steam boilers

◊ Ensure that a Water Treatment Company or Chemical Cleaning Company provides full certification that all pre-cleaning and inhibition has been carried out in line with BS standards

◊ Use automatic dosing and blowdown systems to control chemical dosage and blowdown in line with steam usage

◊ Control boiler Total Dissolved Solids (TDS) at maximum level recommended in BS 2486 guidelines

◊ Regular on-site tests for
  - Oxygen scavenger
  - Alkalinity
  - Total Dissolved Solids
  - Feedwater pH
  - Pre-treatment plant hardness or conductivity

◊ Where there is a potential for condensate line corrosion amines should be used to
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- Protect steam and condensate lines. For Food/drinks and Healthcare plants make sure that ingredients have FDA approval.
- Consideration should also be given to using non-amine based condensate treatments for the milk industry where amines are not approved for condensate use.
- Water Treatment Company to test each system at an agreed frequency for the following minimum analyses:
  - Alkalinites
  - Phosphate/sludge conditioner
  - Total Dissolved Solids (TDS)
  - Feedwater pH and iron
  - Raw water pH and iron
- Schedule annual system inspections.
- Ensure that the water treatment company advises on how to minimise water, energy and chemical usage.
- See Addendum 3 enclosed which shows the costs of operating a poorly treated steam boiler.
Addendum 1

Costs of Operating Poorly Treated Cooling Towers and Evaporative Condensers

Scale acts as an insulator so the more scale you have on the coils of an Evaporative Condenser or on heat exchange surfaces being cooled by a cooling tower the more electricity that will be required to operate the system recirculation pumps and thermostatically controlled fans. These increased costs are as follows:

◊ Less than 0.5 mm of scale increases electricity costs by 11%

◊ 1.2 mm of scale increases electricity costs by 33%

◊ 1.5 mm of scale increases electricity costs by 44%.

If you are responsible for operating or advising on the operation of re-circulating cooling systems it is essential that they are operated in a scale free condition.

Apart from preventing scale and corrosion plus minimising the risk of Legionella bacteria growth on cooling towers it is essential to ensure that towers and evaporative condensers re-cycle the maximum amount of water which in turn minimises water usage. Correctly applied cooling water treatment amounts to less than 5% of the operating costs of a cooling tower and will save many times this amount in reduced water and energy.
Addendum 2

Minimising the Risk of Legionnaires Disease

*Hot and Cold Water Services Checklist*

<table>
<thead>
<tr>
<th>Frequency</th>
<th>Check</th>
<th>Standards</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Cold Water</td>
<td>Hot Water</td>
<td></td>
</tr>
<tr>
<td>Weekly</td>
<td>Low Use Outlets</td>
<td></td>
<td>Flush through weekly</td>
</tr>
<tr>
<td>Monthly</td>
<td>Sentinel taps (nearest, furthest and intermediate points from the feed tank or calorifier)</td>
<td>The water temperature should be below 20°C after running the water for up to two minutes.</td>
<td>This check makes sure that the supply and return temperatures on each loop are unchanged, i.e. the loop is functioning as required.</td>
</tr>
<tr>
<td>Monthly</td>
<td>If fitted, input to TMV’s on a rotational basis.</td>
<td>The water supply to the TMV temperature should be at least 50°C within a minute of running the water.</td>
<td>One way of measuring this is to use a surface temperature probe.</td>
</tr>
<tr>
<td>Monthly</td>
<td>Water leaving and returning to calorifier.</td>
<td>Outgoing water should be at least 60°C; return at least 50°C.</td>
<td>If fitted, the thermometer pocket at the top of the calorifier and on the return leg are useful points for accurate temperature measurement. If installed, these measurements could be carried out and logged by a building management system.</td>
</tr>
<tr>
<td>Quarterly</td>
<td>Dismantle, clean and descale shower heads.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quarterly</td>
<td>Cold Water Storage tanks</td>
<td>Carry out temperature checks</td>
<td>Check temperature at inlet valve and general cleanliness of tanks.</td>
</tr>
<tr>
<td>Six monthly</td>
<td>Incoming cold water inlet (at least once in the winter and once in the summer).</td>
<td>The water should preferably be 20°C at all times</td>
<td>The most convenient place to measure is usually at the ball valve outlet to the cold water storage tank.</td>
</tr>
<tr>
<td>Annually</td>
<td>Water System check to be carried out by independent Auditor/Adviser</td>
<td>Carry out full inspection of the water system and report on any changes or defects. Update schematics if necessary.</td>
<td></td>
</tr>
<tr>
<td>Annually</td>
<td>Cold water storage tanks</td>
<td></td>
<td>Visually inspect and carry out remedial work where necessary.</td>
</tr>
<tr>
<td>Annually</td>
<td>Representative number of taps on a rotational basis.</td>
<td>The water temperature should be 20°C after running the water for two minutes.</td>
<td>This check makes sure that the whole system is reaching satisfactory temperatures for Legionella bacteria control.</td>
</tr>
<tr>
<td>Annually</td>
<td>Calorifier flush and sample</td>
<td>Hot water sample also ensure correct temperatures are present.</td>
<td>Set up flexible hose to drain then flush and sample.</td>
</tr>
</tbody>
</table>

Simplifying Water Treatment the AquaChem Way

Saving Water Energy and the Environment
Actions to be taken if Legionella bacteria is detected

In the case of a positive test result for Legionella the following actions need to be taken:

1. Notification of the positive result to the Nominated Site Person, and depending on the magnitude of the results the following actions should be taken:

<table>
<thead>
<tr>
<th>Legionella Bacteria (cfu/litre)</th>
<th>Action Required</th>
</tr>
</thead>
</table>
| Less than 100                  | - System should be re-sampled to establish extent of colonisation  
|                                 | - Control measures and risk assessment should be reviewed to identify any remedial action required |
| More than 100 but less than 1000| - System should be re-sampled to establish extent of colonisation  
|                                 | - If serogroup 1 to 14 is identified the system should be treated immediately  
|                                 | - Control measures and risk assessment should be reviewed to identify any remedial action required |
| More than 1000                  | - The system should be treated immediately  
|                                 | - Control measures and risk assessment should be reviewed to identify any remedial action required |

2. Remedial actions such as. Cleaning and Disinfection of Domestic Water Systems to be undertaken by a suitably qualified person or appointed specialist as appropriate and any necessary advice and guidance given to the manager of the property. All Cleaning and Disinfection of water systems should be carried out in line with a Method Statement which full complies with L8 Guidelines.

3. On completion of the remedial action, water samples should be taken from the system to confirm the effectiveness of the action taken.

4. A comprehensive record should be kept including test results and details of remedial works undertaken.
**Addendum 3**

**Costs of Deposits on Steam Boilers**

Lime scale acts as an insulator so the more scale you have on the tubes or on the water side of the furnace of a Steam Boiler the more heat loss you have and the more fuel that will be required to produce the required amount of steam. The effects of these deposits are as follows:

<table>
<thead>
<tr>
<th>Scale Amounts</th>
<th>Heat Loss</th>
<th>Fuel Usage Increase</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.8 mm</td>
<td>8%</td>
<td>2%</td>
</tr>
<tr>
<td>1.7 mm</td>
<td>12%</td>
<td>2.5%</td>
</tr>
<tr>
<td>3.4 mm</td>
<td>20%</td>
<td>4%</td>
</tr>
</tbody>
</table>

Soot deposits on the fireside of the tubes of steam boilers also act as a very effective insulator which also increases fuel usage as detailed below.

<table>
<thead>
<tr>
<th>Scale Amounts</th>
<th>Heat Loss</th>
<th>Fuel Usage Increase</th>
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</thead>
<tbody>
<tr>
<td>0.8 mm</td>
<td>12%</td>
<td>2.5%</td>
</tr>
<tr>
<td>1.7 mm</td>
<td>24%</td>
<td>4.5%</td>
</tr>
<tr>
<td>3.4 mm</td>
<td>47%</td>
<td>8.5%</td>
</tr>
</tbody>
</table>
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If you are responsible for operating or advising on the operation of steam boilers it is essential that they are operated in a scale free condition.

In addition the maximum amount of condensate should be returned and the boiler solids should be controlled in line with BS2486 guidelines to maximise efficiency.

Correctly applied boiler water treatment amounts to less than 5% of the operating costs of a steam plant and saves many times this amount in reduced water, salt and energy usage.