

WATER HYGIENE FOR ADIABATIC HUMIDIFIERS

Guidance on good water hygiene for cold water
Humidifiers and Evaporative Coolers

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1 What is the purpose of this document?

This document has been written to aid Condair cold water humidifier customers and users understand their responsibility for hygienic installation and operation of Condair cold water humidifier and evaporative cooling products. This general guidance must also be read in conjunction with appropriate Condair product specific operation and maintenance manuals.

Warning: Your cold water humidifier or cooling system must be installed and maintained in accordance with this guidance, the humidifier instruction manual and in compliance with local legislation. Failure to do so could result in contamination that might cause Legionnaires' disease, which can be fatal. Maintenance must be carried out only by a person or persons who are competent in the task to be performed.

1.1 What legal obligations apply to water systems?

Statutory Dutyholder Obligations

Note: Statutory Dutyholders, can be defined as employers and those with responsibilities for the control of premises, building operator or owner.

The Dutyholder needs to ensure they are aware of their legal obligations regarding Legionella legislation. The following briefly introduces the obligations of a dutyholder.

A Health and Safety Executive (HSE) leaflet briefly defining your Legionella obligations is also available from the HSE website and we strongly recommend you take the time to read this leaflet as a starting point.
Legionnaires' disease - A brief guide for dutyholders -
<http://www.hse.gov.uk/pubns/indg458.pdf>

The Health and Safety at Work etc. Act 1974, Sections 2, 3, 4 and 6 are defined within ACoP L8 as applicable to Legionella control. The first 2 sections cover the primary requirements for most clients: -
(2) It shall be the duty of every employer to ensure, so far as is reasonably practicable, the health, safety and welfare at work of all his employees.
(3) It shall be the duty of every employer to conduct his undertaking in such a way as to ensure, so far as is reasonably practicable, that persons not in his employment who may be affected thereby are not thereby exposed to risks to their health or safety.

The Control of Substances Hazardous to Health Regulations, Regulation 6, Assessment of the risk to health created by work involving substances hazardous to health, is perhaps the most relevant.
(1) An employer shall not carry out any work which is liable to expose any employees to any substance hazardous to health unless he has –
(a) made a suitable and sufficient assessment of the risk created by that work to the health of those employees and of the steps that need to be taken to meet the requirements of these Regulations; and
(b) implemented the steps referred to in sub-paragraph (a).
Legionella are classified as substances hazardous to health and therefore a Legionella risk assessment can be considered a mandatory requirement in all workplace buildings with water systems.

Approved Code of Practice L8 and guidance note HSG274

Specific guidance regarding the control of legionella bacteria is supplied in Legionnaires' disease - The control of legionella bacteria in water systems. Approved Code of Practice and guidance L8 and guidance note HSG274 Part 3. Downloadable from the HSE website - <http://www.hse.gov.uk/pubns/priced/l8.pdf>

As with all foreseeable risk systems, there is a duty to carry out a risk assessment to decide whether further actions are needed and to maintain records of all maintenance carried out, together with monitoring results. These systems and any others found to present a risk need to be adequately controlled and will often require a combination of measures, such as regular maintenance to ensure the system is kept clean, regular disinfection and ongoing monitoring where appropriate.

To comply with their legal duties, dutyholders should:

- a) identify and assess sources of risk. This includes checking whether conditions will encourage bacteria to multiply. For example, if the water temperature is between 20–45°C, if there is a means of creating and disseminating breathable droplets, such as the aerosol created, eg by cooling towers, showers and spa pools; and if there are 'at risk' susceptible people who may be exposed to the contaminated aerosols;
- b) if appropriate, prepare a written scheme for preventing or controlling the risk;
- c) implement, manage and monitor precautions – if control measures are to remain effective, regular monitoring of the systems and control measures is essential. Monitoring general bacterial numbers can indicate whether you are achieving microbiological control and sampling for legionella is another means of checking that a system is under control;
- d) keep records of the precautions;
- e) appoint a competent person (generally referred to as the Responsible Person – RP) with sufficient authority and knowledge of the installation to help take the measures needed to comply with the law.

When carrying out the risk assessment, the dutyholder may need access to competent help and advice. Unless there is sufficient knowledge and expertise within your company, specialist help may be needed to carry out a Legionella risk assessment, and to devise and implement an effective written scheme and monitor its effectiveness.

1.2 Duties of Responsible Person. (RP)

As stated in (e) above the dutyholder should specifically appoint a competent person or persons to take day-to-day responsibility for controlling any identified risk from Legionella, known as the 'responsible person'. It is important for the appointed responsible person to have sufficient authority, competence and knowledge of the installation to ensure that all operational procedures are carried out effectively and in a timely way. Those specifically appointed to implement the control measures and strategies should be suitably informed, instructed and trained and their suitability assessed. They must be properly trained to a level that ensures tasks are carried out in a safe, technically competent manner. If a dutyholder is self-employed or a member of a partnership, and is competent, they may appoint themselves. The appointed responsible person should have a clear understanding of their role and the overall health and safety management structure and policy in the organisation.

2 Pre-installation considerations

2.1 What water supply is needed?

All Condair units are designed to operate with a supply water quality suitable for drinking (Wholesome water). Typical requirements for the supply water are detailed in Section 8.

2.2 Do we need to test the water supply to be sure it meets the requirements?

If the Condair unit is supplied directly from an uninterrupted (not stored or locally treated) wholesome water supply that is and has been in regular use, then testing is probably not required.

Where the supply water quality could be in doubt (for example lack of use or comes from storage tanks) then a sample should be taken to confirm the water quality meets the requirements outlined in Section 5 of this document. Care should be taken to ensure the sample is representative of the proposed supply.

- Pre-flush samples (taken straight away without flushing) are recommended where the objective is to confirm the local supply pipework is clean and free from contamination.
- Post flush samples (taken after cleaning and flushing the sample point) should be used to assess the systemic quality of the water supply (i.e. the bulk water condition).

Condair recommends that where initial sampling has been deemed as appropriate both pre & post flush samples are taken to aid in the interpretation of results.

For these samples to be relevant they should be taken within 30 days of the proposed commissioning date of the system, after completion of the steps in section 3. (It is important to maintain hygiene flushing every 7 days after taking the samples).

Dipslides or Luminescence based rapid measurement (See section 8) are not suitable for evaluation of satisfactory wholesome water quality, which should be achieved by sending a water sample to an accredited laboratory. Condair recommend analysis of Colony count @22°C (TVC), Coliforms, Legionella and Pseudomonas species as an indicator of microbiological quality. (See Section 5).

Additional guidance on sampling is available in BS7592 for Legionella sampling and BS8554 for general sampling of building water systems.

2.3 What materials should be used in the supply system?

Material used in the pipework supply should be considered, copper is the preferred material for humidifier systems although PVC plastic or stainless steel are suitable alternatives. Any pipes using iron, mild steel, or galvanised coatings should be replaced as these are unsuitable. Materials such as natural rubber, hemp, linseed oil based jointing compounds and fibre washers should not be used as they are a nutrient source for microbes.

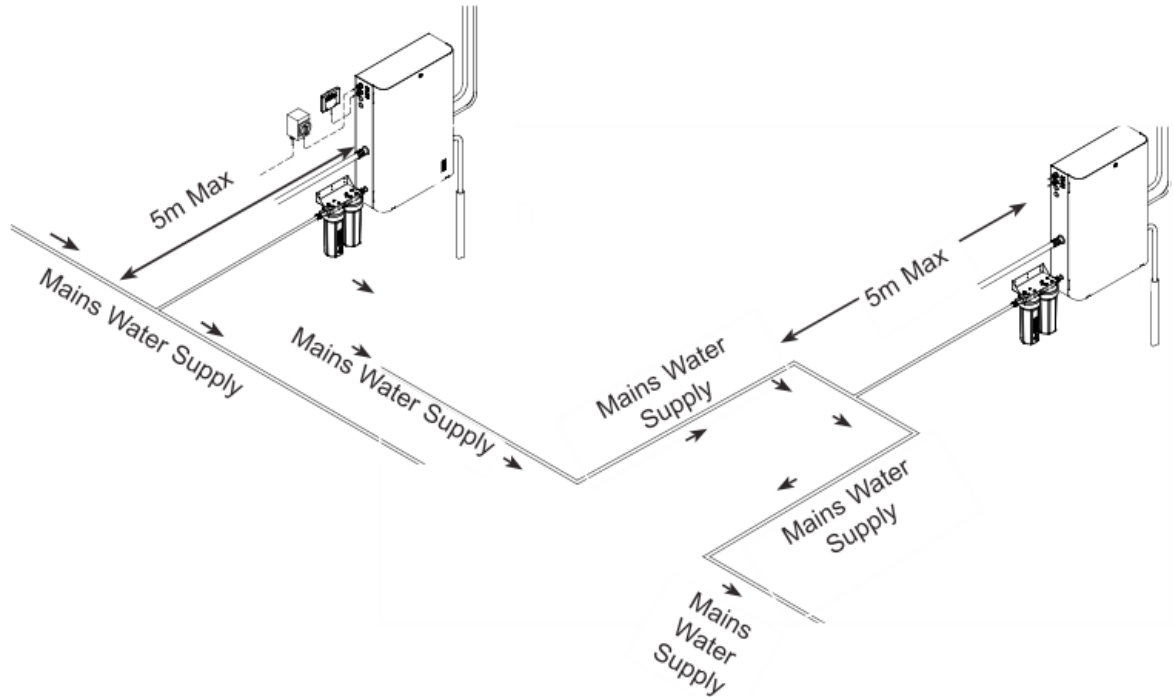
Materials and fittings acceptable for use in the water supply system are listed in the Products & Materials Database published by WRAS.

2.4 Avoiding dead legs

The supply pipework layout should be considered to minimise deadlegs, the humidifier water supply pipe should be arranged such that it is either

- As short as possible in length (ideally less than 5m) from a flowing main
- Looped to minimise the length of potentially stagnant pipe.

Ideal Water Inlet Pipework



Stagnant water rapidly deteriorates in quality; it is therefore important that supply pipework and un-commissioned units are not filled with water and then left to stand in a wet condition. Even when drained pockets of moisture tend to be left behind, see the next section on commissioning.

3 Commissioning

3.1 Pre-commission flushing of the supply pipes

All new pipe should be flushed (cleansing flush) prior to connecting the humidifier, to remove any foreign bodies and solder flux. Condair suggest where new supply pipes are up to 22mm in diameter and less than 10m in length, full bore flushing for several minutes is likely to be sufficient. The installation plan should allow for this within 30 days of commissioning.

Once wet hygiene flushing, to avoid stagnation, should be carried out on the supply pipe at least every 7 days.

3.2 Pre-commission cleaning of the supply pipes

Condair suggests where supply pipes are above 22mm in diameter, longer than 10m or pipework that may have been stagnant for more than 30 days will require full bore flushing followed by a disinfection. Once wet, hygiene flushing, to avoid stagnation, should be carried out on the supply pipe at least every 7 days.

Flushing and disinfection should be carried out in line with the guidance in BSI PD 855468:2015 Guide to the flushing and disinfection of services supplying water for domestic use within buildings and their curtilages.

Cleansing flushing - use of water for the removal of:

- any debris and organic matter that encourage the growth of biofilms and subsequent deterioration of water quality;
- any excess of flux which can cause corrosion of copper pipes if left in place under conditions of low or no flow; or
- the residues of all disinfection

Hygiene flushing:

- drawing off water for the avoidance of stagnation

3.3 Commissioning the humidifier

Water stagnates rapidly and should not be introduced into the Condair unit prior to commissioning and subsequent disinfection.

Part of the commissioning process is an appropriate disinfection of the control valves, reservoirs, distribution pipes and nozzles. Ensure that the relevant chemicals, equipment and Personal Protective Equipment are available to carry out disinfection as per the method statement for each humidifier type.

The operating manual for each humidifier type contains specific instructions for setting and adjusting the purging and hygiene functions for each humidifier design. This commissioning is best conducted by a Condair technician as failure to complete all steps could greatly increase the risk of bacterial contamination.

1 month and 6 monthly commissioning review

It is strongly recommended that 1 month after commissioning, and 6 months after commissioning, an inspection and review of the system is made by a suitably qualified engineer. This is necessary in order to check that the unit is functioning correctly and to make any minor adjustments that maybe required. These checks will also enable you to work out how often servicing will be required.

4 Ongoing responsibilities for maintenance & water testing

4.1 Automatic flushing

Condair cold water systems are supplied with automatic flushing programs, therefore the control units should be left powered on continuously to ensure flushes occur at the designed intervals and water does not stagnate.

4.2 Safe Isolation

Ideally cold water humidifiers and evaporative coolers should not be electrically isolated for periods exceeding 24hrs as the automatic flush and purge cycles will be disabled.

If the system is isolated or powered off for up to 7 days the supply pipework should be purged (minimising splashing to avoid aerosols). All parts of the humidifier should then be flushed to ensure fresh water is in use, before returning the unit to service.

If the system is switched off for a period between 7 and 30 days the system should be risk assessed to determine if the system can be switched back on after flushing (as above) or if a full disinfection is required. Possible considerations that may support a simple flush: -

- Good performance prior to isolation
- No known issues with supply water quality (No storage vessels)
- Low ambient temperatures
- Empty reservoirs & dry evaporative media (evaporative units)
- Low exposure potential.

If the system is isolated or powered off for prolonged periods (i.e. 30 days or more) the system and supply water cleanliness should be assessed prior to putting back into operation. Re-commissioning will be required including cleaning and disinfection.

4.3 Visual Inspections

A biofilm refers to the formation of microbial cells on surfaces that are not removed by gentle rinsing, enclosed in a 'gel' of primarily polysaccharide sugar like material. The biofilm may also encapsulate local environmentally present contaminants (scale, rust, dust etc.).

Most water systems (particularly circulating systems such as evaporative humidifiers and coolers) will develop some degree of biofilm, normally controlled at a level that does not adversely affect the water quality (which is dependent on the particular water application).

Condair cold water humidifiers should not generate excessive biofilms that could result in poor circulating water quality.

If part of a humidifier or cooler is found to have a slight biofilm sufficient to be felt but insufficient to accumulate when rubbed then it should be wiped clean ideally with anti bacterial wipes. The period of re-growth should be logged and set as a cleaning function.

If a unit is found to have a visible biofilm, or a physical build up sufficient to be scrapped off a surface then your Condair representative should be contacted to discuss appropriate actions.

Typically this will involve:

- Checking the functional operation of the humidifier or evaporative coolers hygiene functions,
- Testing the feed water supply. In particular Pseudomonas levels.
- Checking the rating and efficiency of any air filtration (Evaporative Humidifiers and Coolers)
- Adjusting future maintenance and cleaning schedules.

- Adjusting future water sampling schedules.
- Disinfecting.

4.4 Water testing for general bacterial activity

At regular intervals humidifiers should be tested for possible water contamination using the method preferred such as Dipslides, Luminescence based rapid measurement (see Section 8) or Laboratory analysis by culture.

Please note however dipslides and rapid techniques would only generally indicate if there was a significant problem (due to the poor limits of detection this should only be used as a guide).

It is good practice and helpful when sampling to take and record readings of water temperatures.

Evaporative humidifiers and coolers	Low pressure water and air spray Humidifiers	High pressure spray humidifiers
At least monthly (or as per site specific risk assessment) – take water sample from the water reservoir	6 Monthly (or as per site specific risk assessment) - take a water sample from nozzle feed	6 Monthly (or as per site specific risk assessment) - take a water sample from nozzle feed

Dipslides should be incubated for 2 to 3 days at 20 to 25°C. Note dipslides (and Rapid luminescence techniques) are only semi-quantitative and should only be used as a guide to microbiological contamination. (See section 8).

4.5 Water testing for Legionella

Samples should be taken from the humidification system according to a planned sampling procedure. Typically, samples should be taken as close as practicable to the point of droplet release, and be reflective of operational conditions, pre-flush samples. (Ideally not collected directly after disinfection, draining or flushing).

It is good practice and helpful when sampling for Legionella to take and record readings of water temperatures.

Evaporative humidifiers and coolers	Low pressure water and air spray Humidifiers	High pressure spray humidifiers
6 Monthly – From the water reservoir	6 Monthly - Take a water sample from nozzle feed	6 Monthly - Take a water sample from nozzle feed

The Legionella risk assessment may suggest increased sampling frequencies based on the susceptibility of individuals, design considerations or raised operating temperatures (above 20°C).

Analysis of water samples for Legionella should be performed in laboratories with UKAS accredited methods to the current ISO standards for the detection and enumeration of legionella included within the scope of accreditation.

4.6 What to do with the results of water testing

The Responsible Person should ensure all monitoring results are recorded and kept for at least 5 years to meet HSE guidance.

The results of the water sampling should be compared to the guidance given in Section 6 “Tested reservoir or nozzle feed water guidance”

One off raised TVC count is not unusual and can be caused by sampling location, the operational cycle and short term contamination. If a raised count is obtained the unit should be inspected for obvious faults, flushed and resampled.

If you have repeated microbiological activity above the guidance levels in Section 6 then you should consult Condair for further guidance. (Also see section 4.9 “Adapting the Maintenance Schedule”)

Typically this will involve:

- Checking the functional operation of the humidifier or evaporative coolers hygiene functions.
- Confirming the supply water quality and turnover / use patterns, unusual temperatures or food sources.
- Checking the rating and efficiency of any air filtration (Evaporative Humidifiers and coolers)
- Adjusting future maintenance and cleaning schedules.
- Adjusting future water sampling schedules.
- Performing a clean and disinfection and resampling 7-10 days later.

Legionella counts above 100 cfu /1000ml should be investigated, a review of the risk assessment, outstanding issues or operational failures conducted.

Counts above 1000 cfu /1000ml will require the system to be taken off-line and remedial works undertaken, including cleaning and disinfection.

4.7 Cleaning and Disinfection

Evaporative humidifiers operate without using continuous chemical disinfectants to avoid potential carryover into the conditioned air. All open water systems, particularly those mixed with air may become fouled with debris from airborne contaminants. Depending on operating conditions the humidifiers will need cleaning and if a significant biofilm develops (a slimy deposit thick enough to be seen and wiped off the surface) a disinfection may be required.

In accordance with the HSE ACOP L8 the control of Legionella bacteria in water systems cold water humidifiers must be regularly disinfected. Condair recommends that routine disinfection should take place in the following situations:

- a) At initial commissioning.
- b) Where routine sampling, the monitoring & control regime or risk assessment shows it to be necessary.
- c) At regular intervals.

Evaporative humidifiers and coolers	Low pressure water and air spray Humidifiers	High pressure spray humidifiers
6 Monthly – Clean and disinfection	6 Monthly - Disinfection	6 Monthly - Disinfection

- d) If the system or part of it has been shut down (isolated for periods outlined in section 4.2) and/or substantially altered creating a risk of contamination.

Cleaning and disinfection is a specialist operation and should not be conducted by staff without evidence of a suitable written risk assessment, method statement and staff competence.

Once a system has been disinfected the water will need to be retested. This should be done approximately 7-10 days after disinfection has been carried out. The purpose of retesting 7-10 days after a disinfection is not to test the effectiveness of the disinfection (this is taken for granted) but to show that the cause of any contamination has been resolved and has not reoccurred.

4.8 Water treatment & filtration replacement

Many Condair humidifier models incorporate filters, Silver dispensers, ultraviolet light or other hygiene aids that require regular replacement to remain effective. These must be replaced in accordance with the instructions in the specific user manual.

4.9 Adapting the maintenance schedule

In the event that there are persistently high levels of microbiological contamination in your water sample results the frequency with which the humidifier and water treatment system are inspected, maintained and cleaned should be increased to monitor and control the situation.

When routine monitoring indicates the level of microbiological contamination is consistently low the frequency of sampling and testing may be reduced but account should be taken of any changes in operational or environmental conditions which may affect the system. Any decision to change the pattern of sampling testing and routine disinfection should only be done with the advice of a Legionella risk assessment from a competent individual or organisation

5 Supply Water Quality Guidance

	Evaporative humidifiers and coolers	Cold water and air spray humidifiers	High pressure spray humidifiers
Temperature °C Within 2 minutes	< 20	< 20	<20
Colony count 22°C cfu/ml	Ideally < 100 Mandatory < 1000	Ideally < 100 Mandatory < 1000	Ideally < 100 Mandatory < 1000
Coliform cfu/100 ml	< 1	< 1	< 1
Legionella cfu/1000ml	Not detected (< 50)	Not detected (< 50)	Not detected (< 50)
Pseudomonas species cfu/100 ml	< 10	< 10	< 10

6 Tested reservoir or nozzle feed water guidance

	Evaporative humidifiers and coolers	Cold water and air spray humidifiers	High pressure spray humidifiers
Temperature °C Within 2 minutes	< 20	< 20	<20
Colony count 22°C cfu/ml	Ideally < 100 Mandatory < 1000	Ideally < 100 Mandatory < 1000	Ideally < 100 Mandatory < 1000
Coliform cfu/100 ml	< 1	< 1	< 1
Legionella cfu/1000ml	Not detected (< 50)	Not detected (< 50)	Not detected (< 50)
Pseudomonas species cfu/100 ml	< 10	< 10	< 10

7 Grey / recovered water (Non-Wholesome) supplies

Greywater or recovered water would not typically be appropriate for use in Condaire spray humidifiers.

Evaporative humidifiers / coolers

Greywater or recovered water is not recommended by Condaire for use in evaporative humidifiers. Controlled substances not likely to be present in Drinking water could cause a problem, many substances can be toxic. (For example Vinyl chloride which is highly toxic, flammable and carcinogenic could be evaporated and passed to the airflow). It is important therefore that any supply water coming from grey water recovery, rainwater or treated effluent (Non-Wholesome) supplies that may contain these or other contaminants is very carefully assessed.

<i>Acrylamide</i>	<i>Chromium</i>	<i>Nickel</i>
<i>Antimony</i>	<i>Clostridium perfringens (including spores)</i>	<i>Pesticides</i>
<i>Arsenic</i>	<i>Cyanide</i>	<i>Polycyclic aromatic hydrocarbons</i>
<i>Benzene</i>	<i>1,2-dichloroethane</i>	<i>Selenium</i>
<i>Benzo(a)pyrene</i>	<i>Epichlorohydrin</i>	<i>Tetrachloroethene and Trichloroethene</i>
<i>Boron</i>	<i>Fluoride</i>	<i>Trihalomethanes</i>
<i>Bromate</i>	<i>Lead</i>	<i>Vinyl chloride</i>
<i>Cadmium</i>	<i>Mercury</i>	

Supply water make up guidance

	Evaporative humidifiers and coolers	Cold water and air spray humidifiers	High pressure spray humidifiers
Ammonium mg/l	0.50	0.50	0.50
Calcium mg/l (as CaCO ₃)	< 200	See specific product manual	See specific product manual
Chloride mg/l	< 125	< 250	< 250
Chlorine mg/l	< 2	See specific product manual	See specific product manual
Copper mg/l	< 2	< 2	< 2
Conductivity $\mu\text{s}/\text{cm}^{-1}$ at 20°C	< 650	See specific product manual	See specific product manual
pH	6.5 to 9.5	6.5 to 9.5	6.5 to 9.5
Iron mg/l	< 0.5	< 0.5	< 0.05
Manganese mg/l	< 0.1	< 0.1	< 0.05
Odour	Acceptable to users	Not detectable	Not detectable
Sulphate mg/l	< 250	< 250	< 250
Sodium mg/l	< 200	< 200	< 200
Turbidity NTU	< 5	See specific product manual	See specific product manual

8 Other bacterial test methods - Use of fluorescence (RLU) meters

ATP

ATP is a molecule found only in and around living cells, and as such it gives a direct measure of biological concentration and health. ATP is quantified by measuring the light produced through its reaction with the naturally-occurring firefly enzyme Luciferase using a Luminometer. The amount of light produced is directly proportional to the amount of biological energy present in the sample.

Within a water sample containing microorganisms, there are two types of ATP:

- Intracellular ATP – ATP contained within living biological cells.
- Extracellular ATP – ATP located outside of biological cells that has been released from dead or stressed organisms.

Accurate measurement of these two types of ATP is critical to utilizing ATP-based measurements.

Technology continues to develop but being able to accurately measure different types of ATP offers the potential to assess biological activity in a few minutes.

Condair are aware that at present the absolute RLU (Relative light Units) figure produced for a specific humidifier system is not an absolute value.

Where ATP meters are used Condair suggest that tests are completed in duplicate with TVC readings until a reliable comparison figure can be achieved.

Evaporative Humidifiers and coolers tend to generate results that are dependant on the incoming air contamination, where airborne organics can significantly affect results.

Note dipslides (and ATP) are only semi-quantitative and should only be used as a guide to microbiological contamination. Their limit of detection is around 1000 cfu/ml and therefore they are of limited use for testing wholesome water (The humidifier supply water).

BACTIQUANT®

Bactiquant-water is another fluorescence method used by Condair that targets a naturally occurring enzyme activity in bacteria. The enzyme activity is present in a broad spectrum of bacteria, representing the vast majority of bacteria of interest in a humidifier. The enzyme activity belongs to a class of enzymes called hydrolases.

Bactiquant-water is very sensitive to the presence of bacteria in water samples including suspended as well as bacteria immobilized on particles or in aggregates. With the Bactiquant-water, bacterial contaminants can be concentrated from large volumes of water allowing low analysis time even at relatively low bacterial concentrations (Detection could be 10 times lower than a dipslide). Results are transcribed from light response to a Bactiquant value which has been shown to be able to correlate with plate counts.

CONSULTING, SALES AND SERVICE:

Condair Plc
Artex Avenue, Rustington,
Littlehampton, West Sussex.
BN16 3LN (UK)

TEL: +44(0)1903 850 200
FAX: +44(0)1903 850 345
www.condair.co.uk

