Guidelines for *Legionella* levels in water

A code of practice

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Water Research Commission

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A code of practice

Prepared for the
Water Research Commission
by

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The worldwide increase in infectious diseases and emerging pathogens may, inter alia, be ascribed to human demographics and behaviour, economic development and land use, international travel, and microbial adaptation and change, together with the breakdown of the public health infrastructure. In South Africa, due to the rapid growth in the numbers of immuno-compromised inhabitants coupled with vast technological and industrial growth, a need has been expressed for a tool that will enable both water quality managers and water users to effectively assess and manage the levels of *Legionella* organisms in cooling water.

Good management of cooling towers is of paramount importance today, whether they serve air-conditioning or any of the industrial processes related to power generation, to the oil and petrochemical, chemical, food and beverage, pulp and paper and general manufacturing industries. These guidelines were therefore formulated to assist in the maintenance of industrial and community buildings, hospitals and frail-care centres that use cooling water in cooling towers, evaporative condensers, fluid coolers, humidifiers, air-conditioning cooling, misters, artesian drills, car washes, showerheads, whirlpool systems, dental hand-drills and decorative fountains. Most importantly, the aim of the guidelines is to create an awareness of the modus operandi of *Legionella* as a pathogen and the associated human health risks in order to assist in the measurement and interpretation of sampling programmes, to identify *Legionella* detection procedures, to effectively prevent and control *Legionella* levels in water and to establish monitoring and maintenance measures. Specific outbreak procedures have also been formulated.

The guidelines are intended for use in South Africa, taking into account South African environmental conditions. International guideline documentation, results from outbreaks that have occurred throughout the world, and the National *Legionella* Action Group's research findings were used in the formulation of the guidelines.

I wish to express my appreciation to all those who have contributed to these chapters. Their enduring interest will be essential for updating future editions.

Chief Executive Officer
WATER RESEARCH COMMISSION

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What is *Legionella*?

Legionella organisms are opportunistic pathogens and the causative agents of legionellosis, a debilitating and often fatal respiratory disease. This disease is caused by the inhalation of contaminated aerosols containing the *Legionella* pathogen.

Cooling water systems provide an environment in which corrosion, scale, fouling and microbiological contamination exist. Such conditions in these systems produce an environment that is ideal for the growth of micro-organisms. Therefore cooling water structures that cause aerosols pose a health risk if *Legionella* levels are not controlled.

Why is the control of *Legionella* important?

Human demographics and behaviour, economic development and land use, international travel, microbiological adaptation and change, together with the breakdown of public health infrastructure, contribute to the increase of infectious diseases and emerging pathogens. The rapid increase in immuno-compromised inhabitants in South Africa, coupled with vast technological and industrial growth has resulted in the need for a tool that will enable both water quality managers and users to effectively assess and manage the levels of *Legionella* organisms in cooling water.

The national *Legionella* Action Group and the national research results on *Legionella* proved the necessity to implement guidelines to effectively assist in the control and management of *Legionella* in cooling water.

Cooling water

- ❑ Industry, community buildings, hospitals and frail care centres make use of cooling water in a process in which heat is transferred from one substance to another.
- ❑ Good management of cooling water today is of paramount importance, whether it serves air-conditioning or any other industrial process.

Domestic water

- ❑ Industry, community buildings, hospitals and frail care centres make various use of domestic water in which *Legionella* bacteria may pose a health risk.
- ❑ These uses include showerheads, humidifiers, misters in supermarkets, whirlpool systems, dental hand drills, decorative fountains, car washes, etc.

How can this guide help you?

- ❑ Create an awareness of the *modus operandi* of *Legionella* as a pathogen and the associated human health risks;
- ❑ Assist in the measurement and interpretation of sampling programmes;
- ❑ Identify *Legionella* detection procedures;
- ❑ Effectively prevent and control *Legionella* levels in water;
- ❑ Establish monitoring and maintenance measures;
- ❑ Set out specific outbreak procedures.

Who should use this guide?

Any industry, community building, hospital and frail care centre using water in:

- ❑ Cooling towers;
- ❑ Evaporative condensers;
- ❑ Fluid coolers that use evaporation to expel heat;
- ❑ Humidifiers;
- ❑ Air-conditioning cooling;
- ❑ Swamp coolers (cooling systems using water as extra coolant);
- ❑ Misters (fresh fruit and vegetables);
- ❑ Car washes;

- Showerheads;
- Jacuzzi, steam baths, Turkish baths, whirlpool systems;
- Dental hand drills;
- Decorative fountains.

What are these guidelines about?

- The guidelines represent the quantification of the biological characteristics of domestic and cooling water systems;
- The guidelines describe water quality so as to assist water quality managers to control *Legionella* levels effectively;
- The guidelines specify a set of norms that constitute acceptable and unacceptable *Legionella* levels to determine the quality of water;
- The guidelines explain the health risks resulting from exposure to a range of *Legionella* levels;
- The guidelines stipulate the action or treatment required to maintain or reduce *Legionella* levels.

How were the guidelines formulated?

- The guidelines are intended for use in South Africa taking South African environmental conditions into account;
- International guideline documentation, together with local research findings and expert opinions, was used in the formulation of the guidelines;
- Guidelines from countries with similar environmental conditions, e g Australia, were taken in account;
- The National *Legionella* Action Group's research results have contributed greatly to the formulation of the guidelines;
- Results from outbreaks of legionellosis that have occurred throughout the world were also considered in the formulation of the guidelines.

When is it necessary to test for *Legionella*?

- ❑ As part of a routine monitoring programme;
- ❑ When the environmental source of an outbreak cannot be identified;
- ❑ As part of an investigation into an outbreak or suspected outbreak of legionellosis;
- ❑ To trace the source of contamination;
- ❑ As part of a risk assessment for the prevention and control of *Legionella*;
- ❑ To establish an effective cooling water treatment regime;
- ❑ To establish if decontamination procedures have been properly carried out;
- ❑ Cooling towers of community buildings should be tested for *Legionella* every 6 months while cooling towers of hospitals should be tested every alternate month.

What is *Legionella*?

Legionella bacteria are gram-negative, flagellated, non-spore forming rods of 2-3 µm long and 0,3-0,9 µm wide. Of the 39 species and 61 serogroups, more than 50% of these species have been associated with human disease. The bacterium is ubiquitous, surviving and multiplying in water. The species is widespread in natural fresh water including rivers, lakes, streams and ponds and may also be found in wet soil as well as in potting soil. However, in hot water systems, *Legionella* is found in the highest concentrations in biofilms and at the openings of water outlets.

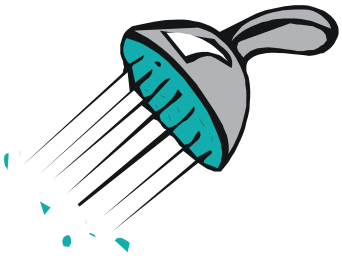
Note

- An outbreak of Legionnaire's disease was diagnosed in 1976 at a convention of the American Legion in Philadelphia;
- Diagnostic tests revealed earlier sporadic outbreaks dating back to 1940;
- Outbreaks of the disease have been linked to the inhalation of contaminated aerosols;
- If more than two people are infected from the same site, it is considered an outbreak;
- Potable water of both the hot and cold water systems causes more outbreaks in Europe than cooling water;
- Whirlpool systems are a major source of infection in Europe;
- *Legionella longbeacheae* from potting soil is a major cause of the outbreaks in Australia and New Zealand;
- Outbreaks generally occur at *Legionella* levels of 1 000 000/ℓ in the source water.

Where do you find *Legionella*?

Legionella is ubiquitous and is found in rivers, ponds, streams, lakes and wet soil.

Routes of transmission are linked to man-made structures associated with the formation of aerosols such as cooling towers, whirlpool systems, showerheads, misters in supermarkets, air-conditioners, hand drills of dentists, decorative fountains, garden sprinklers and car washes.



The *Legionella* bacterium thrives under certain conditions that exist within heating, ventilating and air-conditioning (HVAC) systems. The following environmental conditions are considered favourable:

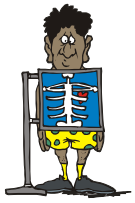
- ❑ Water temperature of 20°C - 45°C favours growth;
- ❑ Growth does not take place below 20°C, but the legionellae may remain dormant in cooling water;
- ❑ *Legionella* does not survive above 60°C;
- ❑ Organisms such as algae, amoebae and other bacteria may serve as hosts for legionellae. The organisms may provide food and shelter for legionellae under less favourable environmental conditions. The legionellae may multiply within these organisms;
- ❑ The growth of algae and the formation of slimes are stimulated by exposure to sunlight. This enhances the protection and growth of legionellae;
- ❑ Biofilms harbour and provide favourable conditions in which legionellae can grow;
- ❑ Elements such as iron, zinc and potassium enhance growth of *Legionella*;
- ❑ Stagnant or low flow water areas encourage growth;
- ❑ Survival of legionellae is enhanced if ambient relative humidity is higher than 65%;
- ❑ Cooling towers operating in a dusty environment are more susceptible to contamination by legionellae.

Note

- ❑ *Legionella* levels are kept under control in well-maintained and treated water systems

How does *Legionella* affect your health?

Legionellosis is the collective term for Legionnaires' disease and the less severe Pontiac fever (Lochgoilhead fever). Pontiac fever is a short feverish illness without pneumonia and is not fatal.



How is legionellosis diagnosed?

Pontiac Fever

This is an acute self-limiting flu-like illness with an incubation period of 24-48 hours. Clinical features include:

- ❑ malaise;
- ❑ fever;
- ❑ chills;
- ❑ headache;
- ❑ non-productive cough;
- ❑ a clear chest x-ray;
- ❑ severe dizziness;
- ❑ complete recovery takes place within one week.

Legionnaires' Disease

This is a pneumonia-like disease that may be fatal. The incubation period is 2-10 days. Clinical features include:

- ❑ mild cough;
- ❑ slight fever to stupor;
- ❑ multi-system failure;
- ❑ fever;
- ❑ malaise;
- ❑ muscle pain;
- ❑ loss of appetite;
- ❑ headache;
- ❑ chest pain;
- ❑ watery diarrhoea (25-50% of cases);
- ❑ nausea, vomiting and abdominal pain (10-20% of cases);
- ❑ rales and abnormally slow heartbeat are typical early in the course of the disease;
- ❑ usually have an abnormal chest x-ray (pulmonary infiltrates).

Note

The following clues should raise the possibility of Legionnaires' disease in cases of undiagnosed pneumonia:

- ❑ Hyponatremia (serum sodium of < 130 meq/mℓ);
- ❑ Failure to respond to B-lactam and aminoglycoside antibiotics;
- ❑ Case related to a large building (hospital, hotel, factory or cruise ship) or exposure to sauna or spa bath.

Laboratory diagnosis

- ❑ Culture of *Legionella* organisms from samples of sputum, tracheal aspirates, transbronchial biopsy, broncho-alveolar lavarge material, or tissue samples taken at autopsy;
- ❑ Detection of *Legionella* serogroup 1 antigen in the urine;
- ❑ Detection of *Legionella* bacilli in tracheal aspirates or other pulmonary specimens by direct fluorescent antibody staining technique;
- ❑ Detection of antibody in the blood of infected people by the indirect fluorescent antibody test (fourfold rise in titre). With the heat-killed antigen an initial titre of >1 in 128 is usually regarded as being suggestive of Legionnaires' disease, but this depends on the extent of exposure to *Legionella* in the community.

Note

- ❑ Legionellosis is a notifiable disease! (ICDO90 040L)

Whom to notify?

Notify Provincial co-ordinators of notifiable diseases. See Appendix B for contact numbers and general information on outbreaks.

Causes and frequency of disease

Causative species	Percentage infection
Legionella pneumophila serogroup 1	91.5
Legionella longbeacheae	4.1
Legionella bozemanii	2.6
Other species	1.8

- The Centre for Disease Control and Prevention (CDC), USA estimates that only 9-15% of the 10 000 - 20 000 cases of Legionnaires' disease that occur yearly in the USA are reported, of which 4 000 are fatal.
- About 23% of these cases are hospital acquired (nosocomial). These nosocomial cases have a higher mortality rate (40%) than the community acquired cases (20%).
- In developed countries, 50% of all pneumonia cases are left unidentified. It is however estimated that 5% of exposed persons are likely to become ill and 1% of pneumonia cases admitted to hospitals are in fact suffering from Legionnaires' disease.
- Antibodies have been found in 25% of adults tested. This suggests that 1 in 4 adults have been infected at some time in their lives, but have not necessarily developed symptoms.

How can you contract legionellosis?

The most common route of infection is through inhalation. However, the risk of

infection increases with:

- ❑ Concentration of pathogen in aerosol;
- ❑ Time of exposure to pathogen;
- ❑ Size of aerosol: 2-5 µm;
- ❑ Respiratory rate;
- ❑ Susceptibility.

Case studies

Outbreaks have been reported as a result of exposure to *Legionella* that is present in different environments such as:

- ❑ The mister in the vegetable section of a supermarket;
- ❑ Whirlpool as decorative equipment at Netherlands flower show;
- ❑ Air-conditioner on cruise ship and/or in hotels;
- ❑ Potting soil (New Zealand and Australia);
- ❑ Hot and cold water systems in hospitals and frail care centres;
- ❑ Air-conditioner outlet vent at aquarium.

Who is most likely to contract legionellosis?

- ❑ The elderly (>55 years);
- ❑ Males are more susceptible;
- ❑ Those in ill-health;
- ❑ Smokers;
- ❑ Alcohol abusers;
- ❑ The Immuno-compromised.

How many *Legionella* bacteria can cause a problem?

As the infective dose presumably varies among individuals due to differences in susceptibility, the number of persons receiving an infective dose should increase as the number of bacteria in exposure increases. Outbreaks generally occur when number of bacteria in water systems is more than 1 000 000/ℓ.

A level of 1 000/ℓ requires no treatment action, as *Legionella* bacteria are endemic at low numbers even in the most natural environments. Therefore, a count of less than 1 000/ℓ is regarded as a level of "not detected".

Note

- The exact infectious dose of *Legionella* is not known.

Health risk assessment for *Legionella*

The assessment of risks associated with different concentrations of *Legionella* bacteria is difficult and controversial because of limited epidemiological evidence, the number of factors involved and their changing interrelationships. In general terms though, the greatest risks for contracting legionellosis are associated with inhalation of droplets of water containing grossly contaminated levels of *Legionella.* Chances of a water-borne infection occurring depend on a number of factors, namely:

- Concentration of *Legionella* species present in the water/cooling water;
- Virulence of the strain;
- Inhalation of water ;
- Infectious dose of *Legionella* species;
- Susceptibility of the individual.

A quantitative health risk assessment is not possible at this stage, as little information is available relating to the dose-response data required to carry out the risk assessment. Outbreaks generally occur when concentrations in water systems have been higher than 1 000 000/ℓ.

As a result of extended exposure periods, the dose received may increase. For instance, if fairly low levels of *Legionella* are present in water, but a person is exposed for lengthy periods, the dose may be significantly increased.

It will not be possible to predict the probability of an illness associated with specific levels of contamination of *Legionella*. To quantitatively predict whether people will become ill it is necessary to know the lethal and sub-lethal doses and these have not been determined. Until such time it will be necessary to make use of the limited data available for recommending guideline levels for *Legionella*.

Why do we need to take a water sample?

To enable the laboratory to analyse the water and to determine the quantity of *Legionella* organisms.

Why is it important to know how to collect a water sample?

Wrong sampling procedures may affect the accuracy of the analytical result and inaccurate conclusions will be drawn concerning the quality of the water. *Legionella* analysis cannot be done on site, the sample needs to be sent to an accredited laboratory (see Appendix A).

Correct sampling procedures

- ❑ Remove cap of the sterile sampling bottle. Take care not to touch inside the neck of the bottle nor inside the cap.
- ❑ Take a sample by filling the container, but ensure a headspace of approximately 20 mm.
- ❑ Screw the cap on well and ensure that the container does not leak.
- ❑ Label the sample with a waterproof marker.
- ❑ Ensure that the sample is cooled for transportation e.g. cooler box with ice bricks - do not freeze.

What equipment is needed for sampling?

- ❑ Sterile 1 ℓ plastic/nalgene/glass containers;
- ❑ Cooler box;
- ❑ Ice bricks;
- ❑ Paper towel;
- ❑ Waterproof marker;
- ❑ Labels;
- ❑ Thermometer;
- ❑ If a biocide is known to be in the water, ensure that the sample is submitted to the laboratory as soon as possible.

What sample containers should you use?

Sterile glass, polyethylene, nalgene 1 ℓ wide mouth, screw capped containers.

When do you sample?

Collect samples before biocide dosing.

What information needs to be given on the sampling label?

- ❑ Sample name/sample number/sample description;
- ❑ Date and time;
- ❑ Name of sampler.

How often do you sample?

Sample sources and frequencies

	Legionella	Total aerobic count
Hospital and frail care centres	every 2nd month	monthly
Community buildings	every 6th month	monthly

How do you transport the samples?

Transport samples cooled but not frozen in a closed isolated container

Where do you not take a sample?

Air sampling is not recommended as a means of measuring potential exposure because of the high likelihood of false negatives.

Special precautions

Details of the origin and volume of a sample and the presence of a biocide must be recorded and must accompany the samples to facilitate the examination and later the interpretation of results. For both safety and analytical reasons, it is not advisable to examine samples of unknown origin of cooling and process waters unless they are accompanied by adequate information. Sampling in the presence of a biocide:

- ❑ If the water sample contains or is thought to contain an oxidising biocide add an inactivating agent to the container before or at the time of sampling;
- ❑ Chlorine and other oxidising biocides are inactivated by the addition of potassium thiosulphate or sodium thiosulphate to the container (1 mℓ of a 30% solution per 1 ℓ of sample);
- ❑ For other biocides, the addition of a universal neutralising agent is not yet practicable;
- ❑ If transport of samples to the laboratory takes some time, particularly if samples are from remote sites, the recommended time interval between collection of the sample and its concentration is ideally 2 days, but must not exceed 5 days;
- ❑ The maximum time allowed from sample collection to culture of the concentrate is 14 days at the storage temperature of 4±3°C.

Where do you sample at cooling towers?

- ❑ Collect sample from the incoming supply to the tower;
- ❑ Take samples from any storage tanks or reservoirs in the system (e. g. chilled water return tanks or header tanks);
- ❑ Collect bulk water samples from cooling water basins as far away from any make-up supplies as possible to prevent incorporating make-up water into the sample;
- ❑ If the tower basin is inaccessible, collect re-circulating water from a valve in the pipe after sterilising and flushing the valve;

- ❑ Collect water returning from the circulation system at the point of entry to the tower;
- ❑ Collect bulk water samples from heaters from the bottom drain valve after sterilising the valve (by swabbing) with 70% alcohol;
- ❑ Take a sample from any standing water in the condensate trays or from the coils.

How do you sample at hospitals and frail care centres?

- ❑ Sample as above if cooling towers are present;
- ❑ Surveys should be performed more often in organ transplant units;
- ❑ All surveys should include hot water tanks and distal sites (showerheads and faucets);
- ❑ Hospitals with <500 beds: examine 10 distal sites;
- ❑ Hospitals with >500 beds: examine 2 distal sites/100 beds.

How do you sample at faucets and showers?

- ❑ Collect samples from showers and distribution points of potable hot and cold water systems after sterilising the outlet with 70% alcohol;
- ❑ Collect a "before flush" or initial flow sample;
- ❑ Collect an "after flush" (flush for 2 minutes) sample when the maximum temperature has been reached;
- ❑ Swabs can be taken from showerheads, pipes and faucets and re-hydrated in water taken from sampling site;
- ❑ Swab samples of scale build-up are taken by removing showerheads, faucet screens and aerators to reach the inside of systems.

Where do you sample at domestic water heaters?

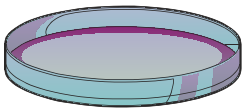
- ❑ Take sample from bottom drain;
- ❑ Collect sample from outlet pipe if plumbing provides access.

Where do you sample at humidifiers, swamp coolers and spas?

- ❑ Sample from the water reservoirs and from the incoming water supply if accessible.

Is it simple to test for *Legionella*?

No perfect method exists for the detection of *Legionella*, although, to date, a culture method is preferable.



Note

- Results of environmental samples can vary widely depending on the techniques used for sampling and culturing. It is vital that industry should use the laboratory of choice for both evaluations of water - before chemical treatment as well as after the chemical treatment. For example, do not send the before treatment sample to one laboratory that uses a specific method and the second, after treatment sample to another laboratory that uses a different method.

What kind of laboratory can test for *Legionella*?

The laboratory requires skilled technologists to perform the analysis and to handle the expensive laboratory equipment required for accurate analyses. The laboratory should be part of a reputable organisation. It is preferable that the laboratory be accredited by a trustworthy organisation e.g. South African National Accreditation System (SANAS) or at least participate in a proficiency test scheme. The organisation must ensure adequate training and ensure that all staff members have sufficient experience to conduct the analyses. Laboratories that conduct the analyses satisfactorily are shown in Appendix A.

What methods are available to test for *Legionella*?

Laboratory test methods need to be sensitive, reproducible, and provide a quantitative result. Rapid detection results are necessary for the prevention of outbreaks of legionellosis . For general surveillance and monitoring of cooling water, detection procedures need to be economical and cost effective.

- ❑ The International Standard, ISO 11731, "Water quality - detection and enumeration of Legionella";
- ❑ The Most Probable Number (MPN) and direct fluorescent antibody techniques method;
- ❑ Other methods of detection used in South Africa are rapid test kits (e.g. Combipack, Binax Equate™ and *Legionella* rapid test kit); and
- ❑ Polymerase Chain Reaction (PCR) - used mainly as a research and confirmation tool.

Test methods

The requirements of a method for the detection of *Legionella* from environmental water samples need to meet certain criteria, which are summarised in the following table:

Test method comparison

Requirements	ISO 11731	MPN	Rapid kits	PCR
Sensitivity	Heat and acid treatment destroys up to 3 logs	Non-selective media and no pre-treatment procedures recover optimum numbers	Heat and acid treatment destroys up to 3 logs	Presence of organic matter in environmental samples interferes with target DNA
Quantitative	Yes	Yes	Yes	Semi
Specificity	No	Yes (two species)	No	Yes (all species)
Actual time	10 days	3-5 days	10 days	24 hours
Skills needed	High	High	Basic	High
Reproducible	Yes	Yes	Yes	Yes
Clinical isolate linked to an outbreak strain	Yes	No	No	No
Viability	Yes	Yes	Yes	No
Cost	High	High	Medium	High

Note

- *Legionella* is classified as a biohazard number 2 organism.

Protection of laboratory personnel handling *Legionella* samples

- Procedures are to be performed in a safety cabinet (special laminar flow cabinet) if aerosols are created;
- Personnel must be familiar with characteristics and pathogenicity;
- Personnel need to be aware of safe handling methods;
- Personnel must have knowledge of emergency procedures in case of an accident.

Can you prevent and control *Legionella*?

Legionellosis is a preventable and avoidable disease. The cost associated with an outbreak, in both human and financial terms, is far greater than the cost of prevention.

Note
❑ *Legionella* levels should not be allowed to amplify to above 1 000/ℓ

How can you prevent legionellosis?

Outbreaks of legionellosis can be prevented if one of the following conditions is controlled or eliminated:

Environmental reservoir → - naturally occurring in all water systems.

↓

Multiplication →
- Stagnation;
- Temperature 20°- 40°C;
- pH: 5 - 8.5;
- Nutrients;
- Scale deposits and corrosion;
- Stratification, sediments, biofilms ;
- Growth of other organisms ;
- "Dead legs" in the system ;
- Inappropriate water treatment chemistry;
- Sunlight.

↓

Dissemination → - Any outlet generating aerosols.

↓

Infectious dose - Primarily by inhalation.

Susceptibility - Some people are particularly susceptible

Prevalence of *Legionella* in cooling towers

- In South Africa about 64% of cooling towers contain *Legionella* levels of 1 000/ℓ (and lower) while 35% show levels of 1 000 -100 000/ℓ and 1% have a level of >100 000 /ℓ.

What are the duties and responsibilities of a maintenance officer?

Note

- All buildings have a maintenance officer responsible for looking after the water and cooling system.

- To perform a risk assessment of all water systems on site;
- To appoint a responsible person to manage the water treatment programme and to document the route of delegated authority;
- To produce a written plan of maintenance to minimise the risk, which includes both remedial works and ongoing maintenance, with written methods covering each task;

- ❑ To train the personnel who will be involved, according to their delegated responsibility;
- ❑ To implement and manage the written maintenance plan and record each task performed in a site logbook;
- ❑ To review the programme regularly to ensure that control is being maintained.

Personnel protection

- ❑ Personnel should wear airline or self-contained breathing apparatus if cleaning methods that create a large amount of spray (high pressure water jetting) are applied;
- ❑ Personnel should at least wear eye protection and a half-face respirator with High Efficiency Particulate Air filters or filters removing 1 µm particles during any cooling tower cleaning procedures;
- ❑ Other ways to reduce the risk to maintenance personnel include decontamination and routine cleaning of cooling towers by chemical treatment of the tower water prior to any physical cleaning being undertaken.

What causes systems to produce positive *Legionella* results?

- ❑ Systems with biofilms and scale deposits or algal growth in the water;
- ❑ Areas of low- or no-flow in the pipe work or stagnation due to very low use of outlets;
- ❑ Low temperatures in potable hot water heaters and distribution systems (<60°C);
- ❑ Stratification of water in water heater;
- ❑ Inappropriate water treatment chemistry applied;
- ❑ Some construction materials such as plastics may harbour and support the growth of *Legionella*.

How can you control *Legionella* levels?

Cooling water

- ❑ Avoid process leaks into the cooling system that provide nutrients for bacteria;
- ❑ Flush or treat areas of no- or low-flow in the system;
- ❑ Apply scale and corrosion inhibitors;
- ❑ Maintain cooling water systems in a clean condition with the application of a routine water treatment programme;
- ❑ Use mist eliminators on cooling towers.

Domestic water

- ❑ Avoid temperatures in the range of 20°C - 60°C at source and 50°C at point of use;
- ❑ Flush areas of no- or low-flow in the system;
- ❑ Routinely heat sterilise every six months for water heaters and hot water distribution systems.

What are the guidelines for controlling cooling water?

Guidelines for controlling cooling water

Legionella /ℓ	*Legionella* level	Risk	Water treatment
< 10 000	Acceptable	Low	Keep on with normal control activities
10 000 - 100 000	Unacceptable	Moderate	Investigate dosing system and/or housekeeping
> 100 000	Totally Unacceptable	High	Take urgent preventative action to reduce levels and exposure

What are the guidelines for hospitals and frail care centres?

Guidelines for hospitals and frail care centres

Legionella /ℓ	Total aerobic count / mℓ	Risk	Water treatment
< 1 000	100	Low	Keep on with normal control activities
> 1 000	>1 000	Moderate to High	Take urgent preventative action to reduce levels and exposure

- ❑ Hospital water sources should have "not detectable" (<1 000/ℓ) *Legionella* levels;
- ❑ The implementation of a control strategy for nosocomial infections should include regular testing for *Legionella* from hospital water systems;
- ❑ All hospitals should perform an environmental survey annually;
- ❑ Monitor cooling towers for *Legionella* levels every alternate month;'
- ❑ Monthly total aerobic counts may serve as a good hygiene tool to assess the efficacy of the water treatment programme and general system cleanliness of health care centres (See Part 6).

Note

- The primary tool for the control of *Legionella* is good hygiene practice. Testing for Legionella levels cannot be a replacement for good maintenance procedures. Levels of *Legionella* in cooling water of hospitals and community buildings, and cooling water at the workplace need to be monitored and controlled at specific time intervals. Maintenance and monitoring programmes, however, need not involve excessive costs.
- The total aerobic counts of cooling systems will indicate the general system cleanliness and the efficacy of the water treatment regime. The total aerobic count may be used to indicate possible risk levels of *Legionella* organisms in the water.

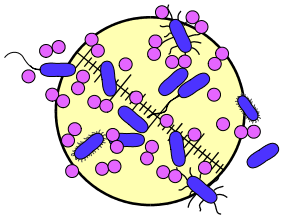
How does the total aerobic count assist in assessing the quality of water systems?

The presence of nutrients in the water provides an environment in which algae, protozoa and bacteria thrive. Therefore, the total aerobic count could be high. As algae, protozoa and bacteria serve as food and shelter for legionellae, they create ideal conditions for the proliferation of the pathogen. The total aerobic count is generally accepted world-wide to assess the quality of cooling water as well as the efficacy of a biocide regime. Apart from the total aerobic counts, performed at 37°C using BCYE agar, dip slides and ATP measurements may be included.

When do you need to perform *Legionella* analysis?

Where a high total aerobic count is found, the presence of *Legionella* organisms should be suspected and appropriate detection for *Legionella* carried out.

How often do you need to do a total aerobic count?

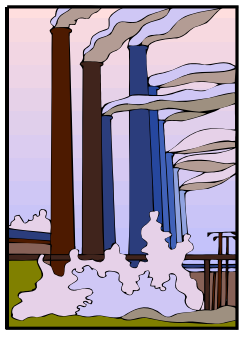


Monthly total aerobic counts are recommended. However, monthly testing for *Legionella* is not warranted as explained below:

- ❑ A low total aerobic count is an indication that a system is under control. If a system is under control then levels of legionellae, in particular *L. pneumophila* serogroup 1, should also be low;
- ❑ A low count does not always indicate a low risk;
- ❑ There are cost and time delays in testing for *Legionella*;
- ❑ A poor correlation exists between concentrations of *Legionella* in the water and the occurrence of infection as other factors play a role e.g. the susceptibility of the host;
- ❑ Interpretation of *Legionella* results is largely subjective;
- ❑ False negative *Legionella* results are possible;
- ❑ A negative result may lead to a false sense of security;
- ❑ Any cooling water system can quickly become heavily colonised if it suffers neglect;
- ❑ Frequency of testing is problematic with re-colonisation occurring rapidly.

What is needed for monitoring and maintaining cooling water of community buildings and industry?

- ❑ Test monthly for total aerobic count;
- ❑ Maintain total aerobic counts below 10 000/mℓ;
- ❑ Monitor *Legionella* levels in cooling tower water every six months;
- ❑ If *Legionella* counts are within the moderate to high risk range (10 000 - 100 000/ℓ), treat water and re-test until *Legionella* counts are within the low risk level (<1 000/ℓ).



What are the guidelines for total aerobic count of industrial and community cooling waters?

Guidelines for controlling cooling water

Total aerobic count /mℓ	Water treatment	Risk
< 10 000	Continue with routine treatment	Low
10 000 - 100 000	Review treatment programme; Monitor total aerobic counts	Low
100 000 - 1 000 000	Review treatment programme; Monitor total aerobic counts	Moderate
> 1 000 000	Test for *Legionella*; Review treatment programme; Monitor total aerobic bacteria	High

What is needed for monitoring and maintaining domestic and cooling waters in hospitals?

- ❑ Test monthly for total aerobic count;
- ❑ Maintain total aerobic counts below 100/mℓ;
- ❑ Include hot water tanks and distal sites in all surveys (showerheads and faucets);
- ❑ If hospital has <500 beds: examine 10 distal sites;
- ❑ If hospital has >500 beds: examine 2 distal sites/100 beds;
- ❑ Monitor *Legionella* levels in water systems every alternate month;

- ❑ If *Legionella* counts are within the acute risk range (>1 000/ℓ), treat water and re-test until *Legionella* counts are within the low risk level range (<1 000/ℓ);
- ❑ Test aerobic count from distal sites (showerheads and faucets) monthly.

What are the guidelines for total aerobic count of cooling and domestic waters in hospitals and frail care centres?

Guidelines for total aerobic count of cooling and domestic waters in hospitals and frail care centres

Total aerobic count /mℓ	Water treatment	Risk
< 100	Continue with routine treatment	Low
100 - 1 000	Review treatment programme Monitor total aerobic counts	Moderate
> 1 000	Test for *Legionella* Review treatment programme Monitor total aerobic bacteria	High

What is risk management?

Risk management is described as the process of identifying, evaluating, selecting and implementing actions to reduce risk to human health and to ecosystems. It integrates the recommendations derived from risk assessments with a number of factors. These factors include cost-effectiveness, technical factors and policy, and business and social considerations in order to identify management options that are both feasible and acceptable to the population.

The following risk management model is recommended as a mechanism for managing and reducing risk of acquiring legionellosis from various water systems. This is the recommended Dutch model to be used for the prevention of legionellosis and infection control:

Risk management model

Action	Prevention
Determine risk factors	Maintain water temp at <20°C and >60°C Avoid slow water flow Control biofilms
Design preventative measures	Increase circulation Remove dead ends Install thermostatic faucets
Apply control measures	Cold water: <20°C Hot water: >60°C Install alarm system Biocide treatment Control *Legionella* levels

(Den Boer **et al.**, 5th International Conference on *Legionella*, Germany, 2000)

Commercial laboratories that are able to perform *Legionella* analysis are as follows.

Place:	CSIR, Environmentek
Address:	P O Box 395, Pretoria, 0001
Contact person:	Estelle le Roux
e-mail:	eleroux@csir.co.za

Place:	SAIMR, Infection Control
Address:	P O Box 1038, Johannesburg, 2000
Contact person:	Rob Stewart
e-mail:	robs@mail.saimr.wits.ac.za

Place:	NCOH
Address:	P O Box 4788, Johannesburg, 2000
Contact person:	Delene Bartie
e-mail:	bartid@health.gov.za

Place:	NCOH
Address:	P O Box 4788, Johannesburg, 2000
Contact person:	Tanusha Soogreem
e-mail:	singht@health.gov.za

The Department of Health, Epidemiological Comments Volume 2, Number 4, p 3 - 6; refers:

The Outbreak Response Team

Outbreak investigation and control is a team effort and it is important that the outbreak control team acts quickly, establishes clear operational guidelines and performs the investigation methodically and responsibly

At National level

A multi-disciplinary outbreak control team has been established at national level. The team consists of representatives from Disease Control and Prevention; Health Information Evaluation & Research, Health Promotion and Communications. This team is responsible for the management and coordination of outbreak control activities and associated epidemiological investigations. The team must be able to respond rapidly and institute rapid control efforts if required.

At Provincial level - Provincial outbreak response co-ordinator

To respond appropriately to disease outbreak, a provincial outbreak response co-ordinator has been appointed for each of the nine provinces. The role includes the co-ordination of all activities and the organisation of team members as well as the co-ordination of communication to the local, national, and international media. The team members will be responsible for addressing issues including medical care, transport, laboratory support, counselling and obtaining technical advice from experts.

The provincial outbreak co-ordinator should utilise the present general national guidelines on outbreak control and, with participation of appropriate individuals and organisations, adapt this plan to provincial conditions. Provincial outbreak investigation and control guidelines include the responsibilities of team members. A system for communicating suspected outbreaks throughout each province would be developed at district level.

The responsibilities of the designated outbreak control co-ordinator include:

- ❑ Develop operational Outbreak Investigation and Control Guidelines;
- ❑ Ensure the development of a system for reporting suspected outbreaks in districts and regions;
- ❑ Co-ordinate outbreak response in accordance with general guidelines;
- ❑ Identify and co-ordinate appropriate resources required for outbreak investigations;
- ❑ Establish the outbreak control team;
- ❑ Communicate with the National Outbreak Control Co-ordinator;
- ❑ Ensure the development of a Provincial Media Plan utilising national guidelines;
- ❑ Ensure the preparation of a preliminary report on outbreaks and that recommended prevention and control measures are instituted;
- ❑ Ensure submission of a final report to the following persons/ organisations namely: provincial Health Authority, the local and district health authorities concerned; the National Outbreak Control Co-ordinator and other organisations involved in each outbreak investigation.

The Provincial Outbreak Control Co-ordinator is not necessarily the Communicable Disease Control Director but someone with organisational and managerial skills to direct a multi-disciplinary team. Each Provincial Outbreak Control Co-ordinator will be able to contact the National Outbreak Control Co-ordinator via a 24-hour emergency number in the event that emergency support is needed from National DOH,

The Provincial Outbreak Control team

The Provincial Outbreak Control team will include representatives of communicable diseases, epidemiology and health information, primary health care and emergency services, hospitals, health promotion, laboratory services, communications, environmental health and District Health Authorities.

The team will collect information; firstly, on the setting of the outbreak such as who became sick; secondly, where the outbreak occurred; and thirdly, describe the

case characteristics. This information will assist in determining the source of the outbreak, the mode of spread, and the identification of those at risk.

The team will analyse the data, compare those who are well with those who are sick, and determine specific risk factors for illness. Ultimately, this information will form the basis of what is communicated to the public and will assist with prevention and control. The team will develop recommendations to address the current outbreak and to prevent future outbreaks.

Responsibilities of different spheres of governance

The District Health Authorities

Outbreak control is the responsibility of the provinces. District and Local Authorities should participate and, when appropriate, initiate and conduct outbreak control efforts. The specific involvement of District Health Authorities will depend on capacities within each district and the nature of the disease outbreak.

Appropriate District Health personnel will contribute to and participate in disease control efforts including contact tracing. Each district will appoint an outbreak control co-ordinator. Their responsibilities will include:

- ❑ Ensure the development of district communication systems;
- ❑ Participate in developing provincial outbreak investigation and control guidelines;
- ❑ Participate in outbreak investigations and control efforts;
- ❑ Communicate with local public, health service providers, and the Provincial Outbreak Control Co-ordinator;
- ❑ Participate in outbreak control media relations;
- ❑ Participate in the preparation of preliminary and final reports on outbreaks.

The Provincial Health departments

Epidemic control is the responsibility of each province. The Directorates of Communicable Disease Control, Environmental Health, Health System Research, and Health Promotion provide support.

Reporting of suspected outbreaks of communicable diseases will be possible via a 24-hour cell-phone of the National Public Surveillance Officer. This number should be available in public and health facilities in each province.

Each province will maintain a directory consisting of the work and home telephone numbers of the provincial outbreak control teams, additional provincial resources, other provincial outbreak control teams, the national outbreak control co-ordinator and team, and other national resources.

The National Department of Health

The National Department of Health's responsibilities include:

- ❑ Provide support to the provincial departments;
- ❑ Develop guidelines for outbreak control;
- ❑ Develop training programmes;
- ❑ Facilitate communication among provinces;
- ❑ Facilitate national and international technical assistance;
- ❑ Publish health information.

National guidelines and training on an appropriate response to a disease outbreak will be formulated in consultation with national, international, provincial, and local experts. The DOH will appoint a National Outbreak Control Co-ordinator and a National Outbreak Control team. The National Outbreak Control Team will include representatives from the following Chief Directorates: Health Information Evaluation and Research, Disease Control and Prevention, National Health Services

The National Outbreak Control Co-ordinator will maintain a directory consisting of the work and home telephone numbers of the National Outbreak control team, additional national resources, and provincial control teams.

The National Outbreak Control Co-ordinators

The responsibilities of the National Outbreak Control Co-ordinators include:

- ❑ Ensure the development of provincial outbreak reporting systems;
- ❑ Assist provinces in co-ordinating outbreak response in accordance with general guidelines;
- ❑ Ensure that provinces have outbreak control guidelines;
- ❑ Establish the National Outbreak ControlTeam;
- ❑ Communicate with provincial Outbreak Control Co-ordinators;
- ❑ Ensure the development of a National Media Plan utilisation;
- ❑ Review preliminary reports on outbreaks;
- ❑ Assist provinces in instituting prevention and control measures and provide staff for technical assistance if requested or required;
- ❑ Review final reports submitted by provinces;
- ❑ Ensure that regular reports on outbreaks are published and are sent to Provincial Outbreak Control Co-ordinators:
- ❑ Assist in implementing outbreak control recommendations;
- ❑ Monitor communicable disease outbreaks in other countries.

Epidemic management is primarily the responsibility of each province. The DOH will have a co-ordinating responsibility:

- ❑ firstly, if requested by provinces;
- ❑ secondly, whenever two or more provinces are affected by the same outbreak; and
- ❑ thirdly, if the outbreak is considered of critical national importance.

Addresses and telephone numbers of Department of Health provincial offices

Office	Address	Telephone	Fax
National	P/Bag X828, Pretoria, 8000	012 312 0000	012 323 5003
KwaZulu-Natal	P/Bag X54318, Durban, 4000	031 305 6071	031 305 7871
Free State	PO Box 227, Bloemfontein, 9300	051 403 3761	051 403 3165
Gauteng	P/Bag X21, Johannesburg, 2000	011 836 2232	011 838 1926
North West	P/Bag X2068, Mmabatho, 2735	018 89 9216	018 89 9220
Northern Province	P/Bag X9302, Pietersburg, 0700	015 295 2851	015 291 5156
Mpumalanga	P/Bag X11278, Nelspruit, 1200	013 752 3107	013 752 6028
Western Cape	P/Bag X19, Bellville, 7350	021 948 8151	021 945 1244
Northern Cape	P/Bag X5203, Kimberley, 8300	053 81 4996	053 833 4394
Eastern Cape	P/Bag X0038, Bisho, 5605	040 609 3946	040 609 3921

Provincial Co-ordinators Information

Name	Address	Telephone	Fax	E-mail	Cellphone
Ms P Moetlo	Department of Health, Northern Province, Private Bag X9302, Pietersburg, 0700	015 291 2010	015 291 2925	PaulineM@dhw.norprov.gov.za	072 258 8233
Ms C Sebekedi	Department of Health, North West Province, Private Bag X2068, Mmabatho, 2735	018 387 5233	018 387 5332	calvinia@nwpg.org.za	082 770 3683
Prof D Durrheim and Dr Billinghurst	Department of Health, Mpumalanga, Private Bag X11285, Nelspruit, 1200	013 752 8085	013 755 3549	daved@sosial.mpu.gov.za	082 335 9748
Ms M Griesel	Department of Health, PO Box 517, Bloemfontein, 9300	051 403 3854	051 430 4958	griesscm@doh.org.za	083 455 8945
Mr J van den Heever	Department of Health, Gauteng, Private Bag X085, Marshalltown, 2107	011 355 3867	011 355 3381	johvdh@lantic.net	082 372 0554
Mrs L Mokotso	Department of Health, Northern Cape Province, Private Bag X5049, Kimberley, 8301	053 830 0761	053 833 4394	pathole@ncape.gov.za	083 276 4875
Ms V Zweigenthal	PO Box 2060, Cape Town, 8001	021 483 2237	021 483 2254		
Ms M Poolman	Department of Health, Eastern Cape Province , Private Bag X0038, Bisho, 5605	040 609 3908	040 635 1205	marlene@impilo.ecape.gov.za	082 823 8200
Mr B Margot	Department of Health, KwaZulu Natal Province, Private Bag X9051, Pietermaritzburg, 3200	033 395 2586	033 342 1714		083 457 1185