



# **A practical guide for the control of Legionella and other bioaerosols in paper mill water systems**

**This paper industry guidance has been developed by the Paper and Board Industry Advisory Committee (PABIAC). It is aimed at duty holders, including employers, and those with health and safety responsibilities for others, to help them comply with their legal duties, and reduce the risk of ill health from exposure to potential legionella bacteria and other bioaerosols in water systems.**

The guidance is not intended to be a substitute for a suitable and sufficient risk assessment or a scheme of control. All duty holders will still have to ensure that controls appropriate to the level of risk in their workplace are taken into consideration including those suggested in this guidance.

Following this industry guidance is not compulsory, unless specifically stated, and you are free to take other action. However, the reader is reminded that certain regulatory requirements do apply as identified within the text of this guidance.

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## Foreword

The Health and Safety Executive (HSE) was involved with PABIAC in producing this guidance. HSE endorses the guidance, as it follows a sensible and proportionate approach to managing health and safety.

## 1. Introduction

1.1 There is a requirement under the Control of Substances Hazardous to Health Regulations 2002 (as amended) (COSHH), together with the associated Approved Code of Practice, for employers to assess the risks of exposure to biological agents (micro-organisms) and either prevent exposure (where reasonably practicable) or control it adequately.

1.2 HSE have issued the ACoP L8 '*The control of legionella bacteria in water systems*', and a series of technical guidance documents (HSG 274).

1.3 HSG 274 Part 1. Gives alert and corrective actions levels based on total bacteria concentrations. However, these levels are not directly applicable to the situation in paper mill process waters.

1.4 HSG 274 Part 3. The control of legionella bacteria in other risk systems is relevant and the advice contained is to conduct a risk assessment of each water system and, depending on the findings, implement a control scheme, including the provision for monitoring, inspection and testing.

1.5 This PABIAC guidance gives further practical advice **specific to the paper sector** on how to assess and control the risk of legionella within the papermaking process in relation to HSG 274 Part 3.

## 2. Scope

2.1 The guidance applies specifically to the papermaking process and includes: water, recycled water, spraying, atomisers, stock preparation and tanks, wet end, press sections, chemical control, and management systems.

2.2 It applies where water is stored or used, and where there is a means of creating and transmitting breathable water droplets (aerosols), thus causing a reasonably foreseeable risk of exposure to legionella bacteria and other bioaerosols (e.g. other bacteria, fungi and endotoxins) derived from process waters.

2.3 This guidance does not address microbiological risks through other exposure routes e.g. ingestion, skin contact, although the measures in place to control *Legionella* would also serve to control inhalation exposure to other bioaerosols derived from process waters.

Additionally, there may be other exposures to bioaerosol that are non-process water derived; in both cases these would also be subject to the requirements of the COSHH Regulations.

### **Areas outside of scope and not included in this guidance:**

- Corrugating and recycling sectors.
- Cooling towers, evaporative condensers (existing HSE guidance in place – HSG 274 Part 1.)
- It doesn't cover hot and cold water system issues such as normal showers, hot and cold taps, etc. (existing HSE guidance in place – HSG 274 Part 2.)

- Fire suppression systems, safety showers (existing HSE guidance in place – HSG 274 Part 3.)
- Waste water systems.
- Other bacterial contamination (except where directly relevant to *Legionella* control)
- Engineering workshops.

2.4 Effluent treatment is outside the scope of this guidance. However, returned treated water is considered a water source within the scope of the guidance and environmental impacts are considered within the context of the control measures which can be applied.

### 3. Background

3.1 In 2015, a total of 382 confirmed cases of Legionnaires' disease were reported in residents of England and Wales, of these 191 (50.0%) cases were considered to have been exposed in the community, 177 (46.3%) cases were associated with travel abroad and 14 (3.7%) had links to a healthcare facility (nosocomial). A total of 35 clusters and outbreaks were identified in 2015.

[https://www.gov.uk/government/uploads/system/uploads/attachment\\_data/file/562685/LD\\_an\\_nual\\_report\\_2015\\_final\\_.pdf](https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/562685/LD_an_nual_report_2015_final_.pdf) In Scotland, there are about 20-40 cases of Legionnaires' disease a year, in Northern Ireland about 5 per year and around half of these are travel-associated.

3.2 There have been **no** reported cases of Legionnaires' disease in the UK associated with the papermaking process. This is despite conditions being conducive to *Legionella* growth and the presence of potential aerosol generating processes/tasks, which could create an exposure risk.

3.3 The process of manufacturing paper involves the use of large volumes of recycled process water, which could be susceptible to contamination by micro-organisms. Such systems may also provide the ideal conditions (nutrients, temperature and stagnation/low flow rates) for micro-organisms to grow at the various stages of the paper manufacturing process. This can lead to slime formation on the surfaces of equipment such as tanks, machine framework or pipework and the subsequent contamination in the water phase. Combined with the possibility that an aerosol maybe be produced, there is a potential risk present that should be assessed and controlled.

### 4. Health and Safety Executive Commissioned Research Report – 'The Microbiology of Paper Mill Process Waters'

4.1 While there are clear circumstances in which bacteria will grow in large numbers in the papermaking process, what was not clear, was whether there was the potential for *Legionella* bacteria to proliferate in the process water used in paper mills. In 2015, the HSE commissioned research into microbial populations typically present in papermaking process waters. One of the aims of the project was to assess whether *Legionella* bacteria could multiply in the process water, and if so, to what levels.

4.2 The research was a collaborative approach with HSE Science Division Microbiology Team (SD), the Food and Environment Research Agency York (Fera) and Public Health England Porton Down (PHE), and nine paper mills, of varying sizes and product type, volunteered to participate in the research.

4.3 On-site sampling and conventional culture-based analysis was undertaken by SD, bacterial population profiling using Next Generation Sequencing (NGS) was undertaken by Fera, and *Legionella* detection was undertaken by PHE, comparing culture and quantitative polymerase chain reaction (qPCR), with the same process used for the detection of *Legionella* by NGS.

4.4 Most process water samples taken from the nine mills tested negative by culture for *Legionella* but positive for *Legionella* by qPCR. This showed that *Legionella* DNA was present, although not necessarily as living bacteria. There was **no clear evidence** that *Legionella* bacteria were multiplying in the papermaking process when comparing levels in **all** source waters tested with **all** process waters tested. However, there were some process waters e.g. headbox and water for discharge where average levels of *Legionella* detected by qPCR were several orders of magnitude greater than those in source waters.

4.5 Process water from all mills sampled revealed levels of bacteria in excess of 1 million colony forming units (cfu) per millilitre and often greater than 10 million cfu/ml. Although there is no health based implication in these values, they are indicative of heavy bacterial contamination and the reason why this guidance is also relevant to controlling exposure to other bioaerosols derived from process waters. This will include endotoxins which are a breakdown product of the cell walls of some bacteria when they die, inhalation exposure can be associated with 'flu' like symptoms.

4.6 Measures such as biocide addition, currently undertaken by paper mills primarily for machine cleanliness, operability and product quality purposes, may contribute to the suppression of *Legionella* and other bacteria growth.

HSE Research Report *The Microbiology of Paper Mill Process Waters* will be available at <http://www.hse.gov.uk/research/rrhtm/>

## 5. Legionella

5.1 *Legionella* bacteria are aquatic organisms and are common throughout nature. They thrive in warm, low flow or still waters (typically between 20-45°C) where there is a good supply of nutrients.

5.2 The bacteria are dormant at temperatures below 20°C and do not survive above 60°C. (Source: HSE) The presence of biofilms/algae, sediment, scale and organic matter in the water harbours and provides favourable conditions for growth.

5.3 Inhaling contaminated aerosol or spray containing *Legionella* bacteria can lead to a spectrum of diseases, (known collectively as Legionellosis) ranging from short, febrile illnesses to serious pneumonia. Cases of pneumonia are classified as Legionnaires' disease, which has a fatality rate of approximately 10-15%.

5.4 The papermaking process uses large volumes of water which is contained and recycled, which makes it susceptible to contamination by a large and diverse population of micro-organisms. The constant introduction of fresh water into the process, whether from a natural source or public mains, will continue to provide a nutrient source. Therefore, any system/piece of equipment if it contains or uses water ought to be considered a potential for legionella bacteria to proliferate.

### Conditions suitable for microbiological (legionella) multiplication / growth

5.5 Paper mills and machines (by their very nature) offer warm conditions, microbiological nutrients, possible water stagnation etc. and may provide suitable microbiological growth conditions.

### Aerosol Creation

5.6 The papermaking process has a multitude of areas where water is sprayed, aerosolised and splashed, all of which could create an aerosol which could be inhaled.

## Susceptible Individuals

5.7 Not everyone exposed to the organism will go on to develop disease, but those with underlying health problems or respiratory disease are more susceptible. Other factors which may contribute to increased susceptibility include being male, over 45 years old, or being a smoker or a heavy drinker.

### **HSG 274 Part 3 - 3.5**

*Any water system that has the right environmental conditions could potentially be a source for the growth of microorganisms, including legionella bacteria. **There is a reasonably foreseeable legionella risk if the water system has a combination of the following factors:***

- *The presence of legionella bacteria in the system, either introduced via the water supply and/or via external contamination;*
- *Conditions suitable for colonisation and multiplication of the bacteria, for example, the water temperature in all or some parts of the system may be between 20-45°C;*
- *Where water is stored or recirculated;*
- *Deposits and materials that are source of nutrients for the organism and support bacterial growth, such as contaminants from the surroundings or process including rust, sludge, scale, organic matter and biofilms;*
- *A means of creating and spreading breathable droplets (aerosols);*
- *The presence of susceptible people who may be exposed to those aerosols.*

### **HSE Guidance: The control of legionella bacteria in water systems – ACOP and Guidance on the regulations: 4<sup>th</sup> Edition 2013 (L8)**

*To comply with their legal duties, employers and those with responsibilities for the control of premises should:*

- *identify and assess sources of risk - this includes checking whether conditions are present which will encourage bacteria to multiply, e.g. is the water temperature between 20-45°C; there is a means of creating and disseminating breathable droplets, e.g. the aerosol created by the process or through a routine or non – routine activity; and if there are susceptible people who may be exposed to the contaminated aerosols, including members of the public*
- *prepare a scheme for preventing or controlling the risk;*
- *implement, manage and monitor precautions - if control measures are to remain effective, then regular monitoring of the systems and the control measures is essential. Monitoring of general bacterial numbers can indicate whether microbiological control is being achieved. Sampling for legionella is another means of checking that a system is under control;*
- *keep records of the precautions and;*
- *appoint a person to be managerially responsible.*

## 6. What you need to do

6.1 In many cases, paper mills will be operating regimes and procedures designed to enhance production and minimise down time. It is recognised within the industry that a significant

negative impact is experienced if the machines are not kept clean and free of microbiological slime build up. If not controlled, this slime can lead to sheet breakages, pipe / pump blockages, reduced heat transfer and poor product quality. Therefore, most paper mills will have procedures in place to control bacteria in addition to keeping the machine and processes clean and efficient.

All the above, in controlling micro-biological levels, may contribute to the control of *Legionella* bacteria. However, such steps alone will **NOT** satisfy the full legal requirements for managing the risk and controlling *Legionella* bacteria under the HSE L8 ACOP and Guidance on the regulations Legionnaires' disease 'The control of legionella bacteria in water systems'.

Guidance on the requirements are covered further in this section.

**6.2 Duty Holder** - If you have identified that there is a foreseeable legionella risk on site, the duty holder (the employer / company director) needs to ensure that suitable controls are put in place, correctly managed and records kept.

**6.3 Responsible Person** - To support the duty holder in this function, the responsible person is appointed and is the individual who needs to have day to day managerial responsibility.

6.4 The responsible person may be the duty holder themselves, an employee of the duty holder, or an external contractor (e.g. a facilities management contractor). When appointing a responsible person, it is important to ensure they have **sufficient authority, competence and knowledge of the installation, including an understanding of the papermaking process**, to ensure all control measures are put in place, and are carried out in a timely and effective manner. They should also have an understanding of *Legionella* risks and the control measures they will be implementing.

6.5 The responsible person (and nominated deputy) will typically manage the *Legionella* control process and support the duty holder in their obligation to meet the requirements of the relevant regulations (Health and Safety at Work etc. Act 1974, Management of Health and Safety at Work Regulations 1999, Control of Substances Hazardous to Health Regulations 2002), and this should include: -

- The *Legionella* risk assessment, including organisation and monitoring the system.
- Creation of a written control scheme.
- Implementation, management and review of the scheme.
- Creation / management of a record keeping system.
- Competency of persons involved in the control scheme

### **Legionella Risk Assessment**

6.6 All paper mills that meet the above 'foreseeable risk' criteria should **as a legal requirement** have undertaken a **legionella risk assessment**. This should consider risks from all water systems and applications on site (e.g. including cooling towers, hot and cold water systems).

**NB:** In the context of this guidance, undertaking a risk assessment relates only to process water systems.

A risk assessment should also detail measures to prevent or control the risk of exposure to *Legionella* bacteria and these should be considered when putting in place a written control scheme.

6.7 Given the importance of this risk assessment from a legal standpoint and as a means of identifying control measures, and given the complexity of paper mill operations, it is likely that

in most cases you will need to appoint someone from outside the organisation. A specialist in *Legionella* risk assessment, particularly with paper mill experience, will bring the right skill set and give credibility to the outcome. In such circumstances, the duty holder should take all reasonable steps to ensure the competence of those carrying out the work. Further information on choosing a competent third party person/organisation and more can be found on the HSE website at <http://www.hse.gov.uk/legionnaires/faqs.htm>

6.8 A team based approach with a combination of skills should be considered to ensure understanding of all aspects of the process, including the tasks that are undertaken, and to implement suitable controls. Providing everyone is suitably informed, instructed, trained and assessed, a typical team may include some of the following positions: Technical manager, experienced process operator, engineer / maintenance, supervisor / team leader and a safety or employee representative etc. In some cases, a representative of the service provider used on site may be asked to join this team as their skill set (e.g. water treatment) will complement the skills of other nominated personnel.

### **Sources of risk in the papermaking process**

6.9 Significant quantities of water are used in the papermaking process. The water can be from a range of sources; typically abstracted from rivers or groundwater (boreholes) with some water supplies topped up or sourced entirely from mains water supplied by utility companies. Water can be, depending on the final product, used many times i.e. recycled within the process. At various stages water will contain secondary material; fibres, fines, fillers. The temperature of the water is often elevated, to meet the required temperature for paper manufacture. Water stored in tanks and pipes may be stagnant or at low flow for periods of time.

6.9.1 Therefore the risk factors include:

- Water that is stored and/or recirculated
- Water in the growth temperature range of 20°C - 45°C
- Nutrients – biofilm/algae, paper fines, fibres etc.
- Rust and scale
- Production of an aerosol/spray/mist

6.9.2 The following areas of the process are likely to include the above risk factors. However, this list is not exhaustive:

- De-inking
- Stock prep: Recycled material
- Stock prep: Virgin material
- Stock approach
- Former section
- Wire section
- Press section
- Size press
- Dryer section
- Finishing
- Water for discharge

6.9.3 Within the process areas, consideration should be given to at least the following areas:

- Water showers used in the process e.g. felt and wire cleaning showers, doctor lubrication showers, ceramic lubrication showers, roll lubrication showers etc.
- Applications where water is used for cutting e.g. edge cutters on the paper machine, water jet slitters in finishing.



- Equipment and plant that is not run all the time i.e. broke tanks, pulpers, refiners and all associated pipework etc.
- The use of wash down hoses and power washers during cleaning on the run, and general clean downs, particularly if using recycled water.
- The mist and aerosols generated around the paper machine former, headbox, wire and press section.
- Any leaks from pipework, pumps, tanks etc.
- Atomiser nozzles used to control dust or humidity.

6.10 The risk from exposure will normally be controlled by measures which do not allow the proliferation of *Legionella* bacteria in the system and, where practicable, by reducing exposure to water droplets and aerosol. When identifying controls, consideration of all aspects of the process, from start-up commissioning to decommissioning of the machine prior to a planned or unplanned shut-down need to be considered. Controls will often be a range of measures rather than just one to manage the risks in the process.

6.10.1 Where practicable within the papermaking process, controls may include the following:

- Minimising the release of aerosol / mist / sprays.
- Avoidance of water temperatures and conditions that favour the proliferation of *Legionella* bacteria and other micro-organisms – i.e. make it too hot or too cold.
- Use of water treatment techniques (including biocides) to maintain the cleanliness of the process water.
- Avoidance of water stagnation – including removing dead legs in pipes etc.
- Avoidance of the use of materials that harbour bacteria and other micro-organisms, or provide nutrients for microbial growth.
- Maintenance and housekeeping programme for process equipment. i.e. paper machine, pumps, tanks etc.
- Minimise potential exposure to personnel for example, restrict access during cleaning operations.

6.11 It is important to note: when undertaking a *Legionella* risk assessment, as with any risk assessment, not only should consideration be given to the potential exposure areas within the papermaking process, but in addition within these areas, you should identify all routine and non-routine tasks which have the potential for exposing personnel to water droplets and aerosols. The combination of both the general and task related risk assessment for an area should identify what control measures you need to apply, and form part of your Safe System of Work.

An example of combining the two is given in Appendix 1.

### **Prepare a written control scheme**

6.12 The written control scheme is an important document. It will evolve from the risk assessment process and should include the following items:

- A plan or schematic of any water systems and processes in use.
- How the systems should be operated safely: Control Strategies.
- How associated tasks can be undertaken safely with task based risk assessment where relevant.
- What precautions are to be taken: Control Strategies
- Any checks or inspections to be completed on the system: monitoring and control.
- What actions, short and long term, to be taken if there are any failures in the scheme.

6.13 Once the scheme has been created it is essential that it is put into place and followed. If it becomes apparent that aspects of the scheme are not possible or practical to follow, then

the scheme must be reviewed to ensure that an alternative method of control can be put in place. The same would apply if monitoring demonstrates that a risk condition is different from what was originally stated or believed. Any changes to the scheme will require a review of the risk assessment to ensure that it remains valid.

6.14 For the written control scheme to remain effective it is important there is proactive management of the risk and effective communication pathways for all parties concerned.

### **Possible Risk Controls**

6.15 The appropriate control strategy will be derived from the risk assessment and should be based on limiting the favourable conditions for the growth of *Legionella* bacteria in the system and reducing exposure to water droplets and aerosol as outlined above. By applying simple, and in some cases low cost measures, the potential for growth and thereby the potential for exposure can be significantly reduced and appropriately controlled.

The control measures detailed below will also be applicable to the control of exposure to other bioaerosols derived from process waters.

### **Depending on your process one or more of these control strategies could be used**

#### **a) Engineering control**

6.16 As a primary control strategy, consider whether the risk can be engineered out of the system. Examples include removing redundant pipework, enclosing tanks, reduce exposure to aerosols i.e. consider using extraction units or screening. Once you have engineered risks out of the system, consider and implement other control methods to manage any residual risk.

#### **b) Temperature control**

6.17 Temperatures in the range 20 - 45°C favour *Legionella* and other bacteria growth. Consider adjusting the operating conditions as a control factor to avoid temperatures within this range both for stored and moving water.

6.18 Where for operational purposes this is not possible, consider better insulation of pipes, tanks, processes etc. to ensure that cold water is more likely to stay cold (below 20°C) and hot water is likely to stay hot (above 50°C).

6.19 If you are relying on maintaining temperatures (either hot or cold) to manage the risks of *Legionella*, then you should implement a system of temperature monitoring and recording for all stored water.

#### **c) Minimising sources of nutrients**

6.20 Contamination of the water may arise from several sources including scale and debris build-up, sediment of process solids, i.e. recycled material, and environmental contaminants such as leaves, insects and other debris. Dirt and debris in the water helps support bacterial and algal growth, leading to the development of biofilms which are known to harbour *Legionella* bacteria.

6.21 Corrosion of storage and collection tanks, paper machine frame work, motors and pumps, bleed and drain valves etc. may also support growth by providing a surface to which the organisms adhere.

6.22 To limit the build-up of contamination in the water system:

- Implement a system of inspection of storage / collection tanks to check for build-up of sediment and slime formation, biofilm/plant growth or signs of corrosion. (Do not forget to include equipment/plant that doesn't run all the time).
- Drain and clean where there is evidence of deposits, algal/plant growth and biofilm.
- Maintain storage / collection tanks to limit corrosion of internal surfaces.
- Consider using scale and corrosion inhibitors.
- Check spray nozzles on atomizers, showers, water receptacles i.e. doctor blade for evidence of scale build-up and clean where necessary but ideally, at least quarterly or as determined by the risk assessment (this may be more frequent if ambient temperatures are elevated and the nozzles become contaminated with fibre/filler deposits etc.).
- Ensure additive systems do not provide contamination due to such systems sitting idle for extended periods or due to failures in the cleaning regimes.

#### **d) Applying suitable and effective water treatment techniques.**

6.23 As part of the overall control scheme, consider an appropriate chemical treatment of the water system. If chemical treatment is required specialist advice should be sought.

6.24 Any biocide application should include a description of the manufacturer's data on the effectiveness of the biocide, particularly against *Legionella* and details of concentrations and contact times required to reduce bacterial counts. Any products added to the process system as part of a water treatment programme should be supplied with additional health and safety information for storage, handling, use and disposal. A COSHH assessment for their application should also be produced.

6.25 It should be noted that where chemical treatment is implemented, this will require a monitoring programme, including the recording of results and controls to ensure that the treatment chemicals are being dosed in line with the levels and settings from the storage tanks.

6.26 In addition, and as part of your programme, if the routine monitoring of aerobic bacteria indicates higher bacteria count or if there is an increasing trend, you should have a plan in place to bring the level back under control. This is sometimes referred to as an 'escalation' process and should consider all eventualities, not just failures in the water treatment programme.

6.27 Contact details of the service provider should be made available and consideration given to using 'Legionella Control Association' registered companies.

**NB:** Any water treatment programme forms part of the *Legionella* control regime. Subsequent changes to that programme (e.g. product, supplier etc.) are fundamental changes and should be assessed and recorded accordingly.

#### **e) Preventing stagnation**

6.28 Standing or slow circulating water increases the risk of microbial growth and is prone to heat gain. Water system capacities, in particular storage tanks, should be matched to the system demand to ensure adequate flow.

6.29 Where modifications are made to the process or plant, try to avoid creating any dead legs in the system. (NB: A dead leg is a length of water system pipework leading to a fitting through which water only passes infrequently when there is draw off from the fitting, providing the potential for stagnation.)

6.30 When removing existing pipework, operational or 'blind ends'/ cap off the ends back to the main distribution to avoid creating a dead leg. (NB: A blind end is a length of pipe closed at one end through which no water passes.)

6.31 Where areas of stagnant water are identified (and can't be avoided) e.g. standby pipes, hose reels, water lines etc. a programme of regular cleaning, disinfecting or flushing (typically weekly but may be more frequent if the water is heavily contaminated) should be implemented. This should ensure the entire volume of water is flushed through.

6.32 Similarly, regularly flush through pipework containing remnants of fibre/ stock, especially to remove any deposition in valves etc.

#### **f) System cleaning**

6.33 One of the key controls for *Legionella* is the ability to keep the surfaces of a system clean. The regimes seen within paper mills for production reasons require paper machines to be subject to a full shut down and a physical chemical clean. The use of high temperature or caustic cleans will assist in reducing microbial activity if undertaken thoroughly.

6.34 It is important to recognise that this activity can expose employees to sprays, splashes and localised aerosols and these tasks need to be considered as part of your risk assessment process, and included in the safe operating procedures. For example, hosing down with water may disturb old deposits within the process which in turn may create a risk of exposure. Even the water supplying the hoses may contain *Legionella*. Any subsequent controls will form a significant part of the control strategy for a paper machine and therefore the activity, the frequency and the procedures must be captured within the written control scheme as deviations from this could affect the risk.

An example of task related risk assessment for cleaning a tank is included in this document (Appendix 2.)

#### **Records and Record Keeping**

6.35 COSHH requires employers to record the significant findings of their risk assessment and the steps taken to prevent exposure to substances hazardous to health. Employers are also required to keep suitable records of examinations, tests and repairs of control measures. This would apply to any process system in operation within a paper mill.

6.36 Such records are important for auditing processes but primarily to ensure that the precautions put in place to control the risk remain effective.

Examples of records may include, but are not limited to:

- Risk assessment and written control scheme.
- Names of managers and personnel involved in risk management including the responsible person.
- Contact details for above maintenance schedules.
- Schematic diagrams of the engineering layout and associated tanks/ valves etc.
- Periods of system closure/shutdown.
- Precautionary measures i.e. the safe operation of the system to include mechanical, operational and chemical factors.
- Actions to take if results are outside of specified limits.
- Remedial actions taken (corrective action log).
- Cleaning and disinfection procedures.
- Results of any chemical and biological monitoring.

- Training records.
- Review meetings to include time schedules etc.

It is recognised that some of the above information may be held within the risk assessment or written control scheme.

6.37 Record keeping plays an essential part in any control scheme as it not only provides evidence of what needs to be and has been done, but it also enables trend analysis to be carried out which can help predict future situations where risks may occur.

Records that you are legally required to keep include:

- the risk assessment and any reviews
- the written control scheme
- the names and position of persons involved in the scheme
- test, inspection and monitoring, including analytical results
- copies of training records for legionella awareness, sampling etc.
- remedial actions resulting from the above
- details of any of other health and safety issues relating to the scheme (e.g. Chemical Manufacturers Safety Data Sheet / COSHH)

6.38 These records should be retained throughout the period for which they remain current and for at least two years after that period. Records kept in accordance with any monitoring, inspection and tests results should be retained for at least five years.

### **Training & competence**

6.39 It is important that anyone who is exposed to the risk and those involved in managing the risk, are aware of the risk assessment findings, the control scheme, and understand the consequence of poor control of systems in relation to possible health related risk. The risk assessment should determine training needs of individuals involved in implementing the control scheme.

### **Lines of communication**

6.40 Investigation of previous outbreaks of Legionnaires' disease (in other sectors) has identified inadequate management, lack of training and poor communication as contributory factors. Therefore, it is important that roles and responsibilities of individuals are defined within the written control scheme (i.e. who does what, where and when). In addition, it is important to identify lines of communication between all parties.

### **Environmental and process impact**

6.41 As well as the responsibilities to reduce the risk of ill health from exposure to potential legionella bacteria in water systems, consideration should be given to other requirements of the process, other regulations and enforcement agencies in determining the most effective control. For example, mill environmental permits and the requirement to work to Best Available Techniques (BAT) must be considered to minimise fresh water usage and reduce chemical/biocide usage where possible. The impact of chemical control measures on subsequent effluent treatment should also be considered, along with adjusting operating parameters (such as temperature) to the detriment of process efficiency. Failure to consider the knock-on impact of control measures may ultimately be counterproductive. In summary, an integrated approach to control is required.

## Monitoring and routine inspection

6.42 Once the scheme has been developed and all controls have been agreed, it must be implemented and communicated fully to staff to ensure they adhere to it. Monitoring the scheme forms an important part in confirming effective implementation of control measures and facilitates ongoing assessment of risk. Any increased risk identified through monitoring and inspection ought to be reflected through completion of appropriate remedial action and managed in a review of the risk assessment and written control scheme.

6.43 The frequency and extent of routine monitoring will depend on the operating characteristics of the process water system, as will associated control levels. Parameters monitored and control levels for these will vary from process to process and should be set to define an “in control” process for each mill.

An example of a monitoring programme with control levels is included in the document (Appendix 3.)

## Specific legionella testing

6.44 There is no specific guidance given in HSG 274 Part 3 for industrial process waters associated with the paper manufacturing process. *Legionella* testing is advocated in HSG 274 Part 1 for cooling towers (quarterly) and in HSG 274 Part 2 for hot and cold water systems, as required, but only if there is a specific reason to do so.

6.45 The decision to undertake *Legionella* monitoring is down to individual sites and should be informed by the risk assessment. However, it may be justified if you have identified potential ‘high risk’ areas around the process, even if you have a thorough water treatment regime, cleaning regimes, general monitoring and action plans in place. Periodic *Legionella* testing will allow you to demonstrate the ongoing effectiveness of the written control scheme or alert you to the need for remedial action.

6.46 Initial testing should be carried out monthly to allow you to establish baseline levels. The frequency of testing should be reviewed and continued until such a time as there is confidence in the effectiveness of the regime, and from which in-house ‘baseline’ levels can be set.

6.47 Periodic sampling provides a useful indication of the conditions at the time, it is important as part of the risk assessment to monitor trends and make it easier to identify any significant changes that could indicate the need to apply additional controls.

**NB:** In waters that have a high background microbiological count, testing for *Legionella* using culture methods may not be appropriate.

## Remedial actions

6.48 Remedial actions should be defined for each control strategy or system failure as defined by the monitoring programme/control levels. Appendix 3 gives examples.

6.49 Where appropriate, remedial actions should themselves be risk assessed including exposure to *Legionella* as a hazard. This is particularly relevant where actions (tasks) involve cleaning and/or chemical dosing.

## Review of risk assessment

6.50 The risk of exposure to *Legionella* should be reviewed if there are any significant changes to the process or to control strategies, (including water treatment, chemical supplier or programme).

6.51 As previously stated, in many cases paper mills will be operating regimes and procedures designed to enhance production and minimise down time. Such regimes could and should be included in the written control scheme as control strategies. It is important to note; should any such regime change for reasons other than *Legionella* control, for example a change to a biocide programme for runnability, then the overall risk of *Legionella* will need to be reviewed as the control strategy will have changed.

## 7. Other sources of information

7.0 It is not the intention of this guidance to replicate word for word existing information on *Legionella*. However, it is recommended that you read other sources of useful information including:

*The Control of Substances Hazardous to Health Regulations 2002 (as amended). Approved Code of Practice and guidance L5 6<sup>th</sup> Edition.* <http://www.hse.gov.uk/pubns/books/l5.htm>

*Legionnaires' disease The control of legionella bacteria in water systems - Approved Code of Practice and guidance on regulations: 4th Edition 2013*  
<http://www.hse.gov.uk/pubns/books/l8.htm>

HSG 274 Technical Guidance <http://www.hse.gov.uk/pubns/books/hsg274.htm>

BS 8580:2010 'Water quality – Risk assessments for legionella control – Code of Practice;

Health and Safety Executive <http://www.hse.gov.uk/legionnaires/index.htm>

Legionella Control Association <http://www.legionellacontrol.org.uk/>

Water Management Society *Guidance on the Principles of Legionella Risk Assessment in Industrial Process Water Systems*

## 8. Appendices (NB: These are examples and NOT templates)

Appendix 1: Example of an overview risk assessment for the papermaking process.

Appendix 2: Example of a task related legionella risk assessment.

Appendix 3: Example of a legionella monitoring programme.

# APPENDICES


Appendix 1: Example of an overview risk assessment for the papermaking process.

Appendix 2: Example of a task related legionella risk assessment.

Appendix 3: Example of a legionella monitoring programme



## Appendix 1: Example of an overview risk assessment for the papermaking process

Date of Assessment:		Process / Area		Assessment Code Number:	
Issue 1 – Day / Month 2017		Site – Water Systems		Paper MC 1 – Water 001	
Assessment Team:					
Authorisation: This process must only be performed by trained personnel.					
Equipment Required:					
Scoring					
<b>Likelihood</b>	<b>Score</b>	<b>Severity</b>	12 – 25 Must have immediate action	 <p><b>STOP!</b> – If you are not suitably trained to complete this task, <b>do not continue</b> and report to your manager.</p> <p><b>STOP!</b> – Talk to other people in the area, and make sure they are <b>not affected</b> by this work. Make sure they understand what you are doing so they can take precautions to avoid harm.</p>	
Remote	1	Negligible	6 – 11 Reduction action required.		
Unlikely	2	Slight	0 – 5 Continue to monitor.		
Possible	3	Serious LTA			
Likely	4	Very Serious			
Very likely	5	Major threat			
<b>Process Evaluation (Risk assessment &amp; Safe System of Work)</b>					

### Statement of fact.

The process employed at (insert company name) is water based with the addition of reclaimed fibre, starch, fillers and dyes. The fast moving water system, heated to between 43 – 50°C, will be a competitive environment for any organism. The industry has a long history of using this or very similar processes with the application of biocides to the process water. Although the process is designed with a high level of re-use of water, the entire system volume is refreshed with new borehole water approximately every 24hrs. At (company name) the workforce on the paper machine tend to be long serving, often with careers spanning over 25 years in the mill. There is no known record of a reported outbreak or a pattern of illness attributable to the process water. This risk assessment has been raised to ensure the health of our employees, visitors and neighbours is not adversely affected by our process.

Ref	Task / Area / Source	Hazard	L	S	RPN	Actions	L	S	RPN
<b>Process Running</b>									
1	Stock Prep – Hydro Pulper Equipment and area inspection required periodically	Localised bio aerosols including legionella.	3	5	15	Biocide treatment and monitoring regime in place. Limited exposure time during the shift	2	5	10
2	Stock Prep – Drum sorters Equipment and area inspection required periodically	Localised bio aerosols including legionella.	3	5	15	Biocide treatment and monitoring regime in place. Inspection hatch, cover installed on reject sorters to prevent aerosol escape	1	5	5
3	Paper Machine – Wire area Equipment and area inspection required periodically	Localised bio aerosols including legionella.	3	5	15	Biocide treatment and monitoring regime in place. Limited exposure time during the shift De-mister units in operation. Third party legionella testing regime in place Formalise periodic tank inspections.	2	5	10
4	Paper Machine – Press Section Equipment and area inspection required periodically.	Localised bio aerosols including legionella.	3	5	15	Biocide treatment and monitoring regime in place. Limited exposure time during the shift	2	5	10

Ref	Task / Area / Source	Hazard	L	S	RPN	Actions	L	S	RPN
5	Paper Machine – Wet end Machine has high pressure and low pressure showers which run continuously.	Localised bio aerosols including legionella.	3	5	15	Showers use clean borehole water with biocide treatment and monitoring regime. De-mister units in operation Limited exposure time during the shift	2	5	10
6	Cleaning down – Machine Floor Hoses used on machine floor by operators for daily cleaning activities. Water supplied from xxxxx	Localised bio aerosols including legionella.	2	5	10	Hoses use clean borehole water with biocide treatment and monitoring regime. Limited exposure time during the shift	1	5	5
7	Cleaning down – Basement area Hoses used in basement by operators for daily cleaning activities. Water supplied from xxxxx	Localised bio aerosols including legionella.	2	5	10	Hoses use clean borehole water with biocide treatment and monitoring regime in place. Limited exposure time during the shift	1	5	5
8	Size Press – Supplied from xxxxx.	Localised bio aerosols including legionella.	3	5	15	Biocide treatment and monitoring regime in place. Starch and water applied at min. x°C	1	5	5
9	Water Treatment Plant.	Localised bio aerosols including legionella.	2	5	10	Conditioning tank IC reactor Flash aeration tank DAF Dissolved Air Flotation Unit No aerosol when running Periodic legionella sampling tests	1	5	5
<b>Process Shut</b>									
10	Stock prep area – Cleaning activities, especially if slime formation identified.	Localised bio aerosols including legionella.	4	5	20	Biocide treatment and monitoring regime in place for hose water. Identify high risk areas with slime formation and designate as 'high risk' requiring specific control measures and cleaning procedures (See SSoW 001 High Risk Cleaning Activities)	2	5	10
11	Paper Machine – Wire Area Cleaning activities, especially if slime formation identified.	Localised bio aerosols including legionella.	4	5	20	Biocide treatment and monitoring regime in place for hose water. Identify high risk areas with slime formation and designate as 'high risk' requiring specific control measures and cleaning procedures (See SSoW 001 High Risk Cleaning Activities)	2	5	10
12	Paper Machine – Press Section Cleaning activities, especially if slime formation identified.	Localised bio aerosols including legionella.	4	5	20	Biocide treatment and monitoring regime in place for hose water. Identify high risk areas with slime formation and designate as 'high risk' requiring specific control measures and cleaning procedures (See SSoW 001 High Risk Cleaning Activities)	2	5	10
13	Paper Machine – Dry end Cleaning activities. (No slime formation in this area due to no mist or splashing)	Localised bio aerosols including legionella.	2	5	10	Biocide treatment and monitoring regime in place for hose water.	1	5	5
14	Water Treatment Plant - Cleaning activities.	Localised bio aerosols including legionella.	3	5	15	Biocide treatment and monitoring regime in place for hose water. Identify high risk areas with slime formation and designate as 'high risk' requiring specific control measures and cleaning procedures (See SSoW 001 High Risk Cleaning Activities)	2	5	10

Ref	Task / Area / Source	Hazard	L	S	RPN	Actions	L	S	RPN
11	Town water – Domestic supply, Fire hoses, Emergency showers.	Legionella bacteria	3	5	15	<p>1a. Contractor employed to complete periodic checks on the "Towns water system" in order to comply with L8 requirements.</p> <p>1b. Contractor employed to run water through all fire hoses, showers &amp; emergency showers on a weekly basis.</p> <p>1c. Hand sheet maker equipment in the Laboratory flushed out every week.</p> <p>All records are maintained in the Log book on site.</p>	2	5	10

Details of related Evaluations/ Risk Assessments etc	Type & Number of People Affected by the Activity (e.g. Department, Category of persons etc)
<ul style="list-style-type: none"> <li>a) See L8 risk assessment from approved third party contractor for domestic and town water supply</li> <li>b) See L8 risk assessment for process water system.</li> <li>c) See related file – Legionella Control Measures for additional information on biocide treatment, monitoring regime, and SSoW</li> <li>d) COSHH risk assessment for handling, dispensing of water treatment chemicals etc.</li> </ul>	All production personnel, All Maintenance personnel, All Manufacturing Development personnel, Contractors & Visitors.

## Appendix 2: Example of a task related legionella risk assessment

### Task: - Cleaning a recovered fibre stock tank

#### Description of Task Undertaken:

Due to residue build up on the inside of the holding tanks. Once a week the stock preparation operator will drain off the water and power wash the inside of the holding tank. During normal operation, the tank has a closed lid, but as part of the cleaning down activity, the lid is open to gain access. This is a one man operation, although other operators are in the vicinity during the task.

#### Preconditions:

- A risk assessment has been undertaken by a 'competent person' as defined within *The control of legionella bacteria in water systems - Approved Code of Practice and guidance on regulations: 4<sup>th</sup> Edition 2013*
- Inherent risks - The assumption that the water system is or will become contaminated at some point with bacteria.
- Operators are trained in the task.

Task / Area	What is the Hazard	Who is at risk	Existing Controls	Further Actions Yes / No	Who and Date	Review Date
Cleaning a recovered fibre stock tank	Inhalation of legionella bacteria and other bio aerosols.	Operators / employees and third parties	Refer to the main risk assessment and requirements in line with the HSE ACoP <b>Legionnaires' disease</b> the control of legionella bacteria in water systems.  Refer to PABIAC guidance 'A practical guide for the control of Legionella and other bioaerosols in paper mill water systems'.			
	Water temp between 20 - 45 <sup>o</sup> C which will encourage bacteria to multiply.	As above	Inlet water temp is checked and monitored on a weekly basis.  Water temp in storage tank is checked and monitored	Adjustment of operating temperature to avoid the ranges of 20 <sup>o</sup> C - 45 <sup>o</sup> C	Maintenance every week.	Every 6 Months
	Aerosols created by the process.  Nutrient input from recycled material which can cause microbial growth.	As above	Closed loop system does not expose employees to airborne contamination  Biocide treatment and monitoring programme in place  Regular dip slide checks and Legionella tests.  Results are recorded / validated and monitored for increasing trends.	No  Where test results show an increase, additional chemical treatment or action is applied  No	Biocide supplier	
	Slime / biofilm formation on the inside of the tanks and agitator.	As above	Visual inspection on the condition of the tank and water - evidence of scum / sediment, rust or corrosion.  Stock tanks are in constant use 24/7.	Daily by operators  Programme in place for flushing and purging the system if the process is down for > 24hrs	Team Leader	
	Stagnant water in dead legs.	As above	All dead legs have been removed from the holding tanks to the water inlet and outlet pipes.	Where modifications are made to the process or plant, consideration is given		

				to avoid creating any dead legs in the system.		
	Stagnant water in hose lines, which could encourage bacteria to multiply		Chemical cleaning and disinfection programme in place. Hose lines are cleaned through every 2 weeks.	Refer to monitoring programme		
	Localised aerosol exposure through spraying and splashing		<p>The method of cleaning will determine the necessary control measures which will need to be in place.</p> <ul style="list-style-type: none"> <li>• Cleaning the tank by hand will reduce the risk of exposure to aerosol contamination.</li> <li>• A hose pipe with limited water pressure can confine aerosol exposure.</li> <li>• The use of a high pressure cleaner is likely to create a large amount of aerosol contamination.</li> <li>• The addition of a suitable cleaning agent as part some pre-treatment process may assist with the breakdown of material, and limit exposure time.</li> </ul> <p>Demister units are in operation during clean downs.</p> <p>Operators are fully trained and competent.</p> <p>Depending upon the method of cleaning and if pre-treatment chemicals are being used a selection of PPE / RPE to an approved standard are worn during the clean down operation.</p> <p>Low level health surveillance for dermatitis including skin checks in operation.</p> <p>Limited expose to other employees during the clean down operation. Area is cordoned off.</p>	<p>SSoW had been written for this task. All operators need to have read and understood these procedures.</p> <p>Team leaders to ensure compliance with the SSoW.</p> <p>Install Local Exhaust Ventilation above the tanks to remove aerosols.</p> <p>Routine and annual LEV checks are carried out,</p> <p>Operator checks units prior to commencing task.</p> <p>Keep training records up to date.</p> <p>Ensure compliance with SSoW.</p> <p>System in place for dealing with any OH issues raised.</p>	<p>Operators</p> <p>Team Leaders</p> <p>Engineering Manager</p> <p>Safety Manager</p> <p>Team leader</p>	As required legally
	Lack of monitoring of compliance with existing control systems		<p>Clear lines of communication and responsibility identified within the company.</p> <p>Treatment chemical rates are monitored to ensure the correct dosage is applied</p> <p>Visual check of all treatment drums, chemical storage areas.</p> <p>Access to competent advice</p>	<p>Review current preventative maintenance programme to ensure that all items are covered and where appropriate records have been kept of all maintenance work.</p> <p>Review annually</p>	<p>Responsible person(s)</p> <p>Duty Holder</p>	<p>Annually</p> <p>Annually</p>

### Appendix 3: Example of a legionella / microbiological control monitoring programme

	Description	Responsibility	Period	Control Level	Action if outside of control level
<b>Legionella Samples</b>	Sample x points around the process. Sample points identified on schematic diagram and within the written scheme. Details in responsible person (name of person or company) folder Sampled by independent responsible person Tested by independent approved third party.	Site responsible person to schedule	Quarterly	No Legionella detected	Retest immediately. If second set is positive, investigate affected section Retest after wash – negative result required to demonstrate affective clean. Further disinfection if positive result
<b>Borehole Water</b>	Check dosing pumps running	Site maintenance	Daily	All running.	Identify fault if possible and fix. Contact biocide supplier for support if necessary
	Check dosing equipment operation and biocide usage	Biocide supplier	Weekly	All running, chemical usage on target	Report any issues to maintenance dept. Agree actions and timescales to resolve any problems (provide new pumps if required)
	Test samples from x area and y area for free halogen. (Confirm with biocide supplier test method)	Biocide supplier	Weekly	0.2 – 0.5ppm free chlorine residual <1ppm total chlorine (vapour phase corrosion)	Adjust dose flow to maintain target levels (Trends reported in weekly report)
	Perform dip slides on samples from X and Y (TAC and Yeast/ Moulds)	Biocide supplier	Weekly	<10 <sup>7</sup> cfu TAC	Report level to maintenance dept. Increase dose flow to regain control. (Trends reported in weekly report)
	Check ATP, pH, redox, conductivity of X and Y	Biocide supplier	Weekly	N/A	Report any unusual values to maintenance dept ((Trends reported in weekly report)
<b>Process Water</b>	Check dosing pumps running	Site maintenance	Daily	All running.	Identify fault if possible and fix. Contact biocide supplier for support if necessary
	Test clarified water sample (X and Y) for Calcium hardness (Bacterial activity increases VFA levels which increases dissolved Calcium in the process water)	Site maintenance	Daily	1800 – 2500ppm	Adjust dose time to each ply to maintain levels. Check ratio of VFA to COD once per week to ensure health of WTP
	Check dosing equipment operation and biocide usage	Biocide supplier	Weekly	All running, chemical usage on target	Report any issues to maintenance dept. Agree actions and timescales to resolve any problems (provide new pumps if required)
	Perform dip slides on samples from X designated process sample points (TAC and Yeast/ Moulds)	Biocide supplier	Weekly	<10 <sup>7</sup> - 10 <sup>7</sup> cfu TAC	Report level to maintenance dept. Increase dose time to regain control. If TAC level is unresponsive after changes, schedule a system clean for next maintenance shutdown. (Trends reported in weekly report)
	Check ATP, pH, redox, conductivity of X designated process sample points	Biocide supplier	Weekly	N/A	Report any unusual values to maintenance dept ((Trends reported in weekly report)
	Perform caustic system clean	Maintenance / Production	Min X/yr	N/A	Increase frequency if TAC or other indicators are not responding to biocide addition increases.
<b>Review</b>	Review Risk Assessment and include whether any exposure sampling should be scheduled or repeated	Site responsible person	Annually or when a process change identified	N/A	N/A

