Loss Prevention Council

Technical
Briefing note
for Insurers

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LEGIONELLA AND FIRE FIGHTING SYSTEMS

This *Technical Briefing Note* is part of a series of publications from The Loss Prevention Council. *Technical Briefing Notes* offer information and guidance for insurers and others on topical issues. They are intended to provide early advice where attitudes and loss prevention measures are not fully established. They present an in-depth critical review of current knowledge and practice together with references and sources of further information. Where appropriate The Loss Prevention Council will produce additional *Notes* on the topic, or more detailed reports.

This *Note* has been prepared by The Loss Prevention Council. Further information on this issue can be obtained from Dr Richard Bailey at The Loss Prevention Council.

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SUMMARY

- The term Legionellosis covers a group of diseases (which includes legionnaires' disease, a form of pneumonia) that can be contracted by inhaling water droplets or aerosols containing bacteria from the genus *legionella.*
- There are roughly 175 cases of legionnaires' disease in England and Wales per year, the mortality rate being about 10-15%. These cases are usually associated with water towers for air conditioning systems.
- The operation of fire fighting systems (sprinklers, drenchers and ring mains) may create inhalable water droplets. However, the conditions normally found within fire fighting systems are not thought able to support the growth of populations of *legionella.*
- The risk of catching legionellosis from a properly installed and maintained fire fighting system is negligible, although this risk may increase for private water supplies, for maintenance personnel and in health care establishments.
- LPC suggested control measures:
  - Incorporate fire fighting system into any existing *legionella* monitoring system for the site.
  - Minimise production of aerosols during testing and maintenance.
  - Maintaining pipes and water storage tanks at <20°C by shielding from possible heat sources.
  - Annual inspection of tanks to monitor corrosion and deposit build-up, with appropriate remedial actions.
  - Annual monitoring of the water tank bacterial concentration by dip slide. Total bacterial concentrations above 100,000 colony-forming units per millilitre (10^5 cfu/ml) indicate that chemical treatment of the water may be necessary.

LEGIONELLOSIS

Legionellosis is the generic term used to cover diseases caused by bacteria from the genus *legionella.* This genus includes the species *Legionella pneumophila,* found in soil and watercourses, which can cause a severe pneumonia (legionnaires' disease, the most common form of legionellosis) in susceptible individuals. The same

bacterium can cause a mild fever (Pontiac fever) in otherwise healthy individuals. Other *legionella* species include *L. micdadei* (non-pneumonic Lochgoilhead fever) and *L. feelei* (pneumonia-type illness).

There are roughly 175 cases of legionnaires' disease in England and Wales per year, the mortality rate being about 10-15%. Infections tend to occur in public buildings (hospitals, hotels, etc.) following contamination of recirculating and/or hot water systems such as air conditioning systems.

Medical aspects

Legionellosis can be contracted by inhaling fine aerosols (clouds of fine droplets and particles) from a water source contaminated with *legionella*. Potential aerosol-producing sources include running taps, showers, fountains, cooling towers, whirlpool spas, and misting devices such as humidifiers. If the aerosols are small enough (≤5 µm in diameter) they can pass deep into the lungs where they may be deposited into the terminal air sacs (alveoli).

Another (theoretical) route of exposure is breathing in of water whilst drinking. There is no evidence that the disease can be transmitted from person to person.

Legionnaires' disease develops within 2 to 10 days after exposure to *L. pneumophila*. Symptoms of legionnaires' disease may include loss of energy, headache, nausea, high fever, and muscular pain, followed by a dry cough and pneumonia. About 50% of patients become confused or delirious and about 30% also develop diarrhoea or vomiting. The symptoms can be indistinguishable from pneumonia and it is possible that many *L. pneumophila* infections are misdiagnosed as viral pneumonia, rather than the bacterial legionnaires' disease.

Pontiac fever develops within five hours to three days after exposure, exhibiting influenza-like symptoms. Victims generally recover in two to five days without treatment

Legionnaires' disease has a reported 1% contraction rate for exposed persons. The infection risk increases with the concentration of *legionella* in the air, the respiratory rate of the individual, the length of time the person is exposed and the ability of the individual to fight off the infection. Persons at a higher risk of infection include:

- Males (who are three times more susceptible than females).
- Adults, particularly those over 50 years.
- Those with pre-existing respiratory disease.
- Smokers.
- Alcoholics.
- Those with immunosuppressive illnesses, e.g. cancer, diabetes, AIDS, or kidney disease.
- Those undergoing immunosuppressive drug therapy, e.g. organ-transplant and chemotherapy patients.

Microbiology of *legionella*

The general requirements for growth of populations of *legionella* are tepid stagnant water with a ready supply of nutrients.

- Growth can occur between 25 - 45°C, the optimum growth temperature being 36 - 37°C. Below 20°C *legionella* is dormant (not killed), while temperatures above 60°C will kill the bacterium.
- Potential nutrients include sludge, scale, rust, organic material (algae, leakage of jointing and sealing materials) or dirt.
- The presence of microscopic organisms (protozoa) such as amoebae can greatly promote the reproduction of *legionella* as the bacteria can multiply intracellularly.
- The optimum pH for growth is between 5.0 and 8.5.
- The presence of oxygen is essential as *legionella* are strict aerobes.

Direct sunlight may inhibit the multiplication of *legionella* but can promote the growth of algae. The formation of biofilms is thought to play an important role in harbouring *legionella* and providing favourable growth conditions. A biofilm is a layer of micro-organisms contained in a matrix, which may form a slime on surfaces in contact with water. Incorporation of *legionella* in biofilms and enclosure within protozoa can protect the organisms from biocide concentrations that would otherwise kill or inhibit *legionella* freely suspended in water.

Legislation

There are no named Regulations for protecting against legionellosis. An approved code of practise is published by Health and Safety Commission[2], detailing the general duties of employers under the Health and Safety at Work Act and Control of Substances Hazardous to Health Regulations for hazardous micro-organisms. Guidance on controlling *legionella* is also published by Health and Safety Executive[3,4]. Legionnaires' disease is not a notifiable infectious disease, although it comes under the *Reporting of Injuries, Diseases and Dangerous Occurrences Regulations* 1995 as a biological agent, so if your employee contracts legionnaires' disease, you have to report it.

FIRE FIGHTING SYSTEMS

Fire fighting systems (FFSs) for a site may consist of a combination of:

- Sprinklers - heat activated heads to control a fire within a building,
- Drenchers - open sprinkler heads for complete water drenching of internal and external areas, or
- Site fire-fighting ring mains - hydrants around the site to which hoses may be attached.

These have connecting pipework and an appropriate water supply. The water supply may be either direct from the public water mains or from a private tank. The FFS may also have an automatic pump to aid the distribution of water. Other FFSs such as portable water fire extinguishers are not considered a risk.

Private tanks may be: a gravity tank, an elevated reservoir or a pressure tank (containing the water under pressure). A

gravity tank or elevated reservoir may be fed from either the mains or another private source (e.g. local river or pond). Example tank materials include concrete, glass fibre-reinforced plastic, galvanised and ungalvanised steel, and butyl rubber lined aluminium. Tanks fed from the mains are required to be cleaned and maintained every 15 years, otherwise tank maintenance is required every 3 years.

The installations (sprinklers, drenchers and ring mains) and pipework are generally constructed of steel, but can be of any appropriate material. Usually, the whole FFS is constantly charged with water. Cleaning of the pipework only occurs if a large amount of corrosion is found in the storage tank or if solid accumulation in pipework is suspected for other reasons.

ASSESSMENT OF RISK

For human infection to occur, any *legionella* present in a FFS would have to grow to an infectious level, be present in an aerosol and be inhaled by a susceptible individual. These stages are assessed below.

Potential for bacterial growth

It should be accepted that some *legionella* will probably be present in all water systems, including supplied mains water. The question is whether conditions in a FFS would support the continued existence and growth of populations of *legionella*. As mentioned above, the general growth requirements for *legionella* are stagnant, tepid and oxygenated water, with a ready supply of nutrients (See Table 1). The concentration of *legionella* regarded as infectious is hard to define, as the infectious dose will depend largely on the method of delivery.

Overall the temperature within FFSs will be below, or close to, ambient at which *legionella* bacteria would be dormant. However, some pipework may become warmer, as might external/roof top tanks or tanks in roof voids.

Water is stagnant in virtually all FFSs, potentially allowing an internal build up of biofilm. However, this is only likely in areas exposed to light, of which there should be none[1]. Some agitation of the water in storage tanks is likely during the weekly pump flow testing.

Nutrients, in the form of rust and scale, will be present throughout the FFS. No organic material should be present in the FFS.

Generally the conditions within FFSs are not thought to be able to support growth of *legionella*, but there is a possibility that a poorly maintained private tank, allowing organic material and warmth to enter, might offer conditions for *legionella* to multiply.

Potential for *legionella* transmission

The potential for droplet formation and dispersal can occur:

- During installation/due to faulty plumbing
- During maintenance/cleaning of pumps (weekly) / tanks (every 3 or 15 years)
- During accidental sprinkler release (very rare) or sprinkler operation.

The droplet size created will be generally of the order of 0.5 mm, compared to the 5 µm (some 100 times smaller) needed to pass into the alveoli. However, smaller droplets can be formed from larger ones evaporating or breaking up, resulting in a potentially inhalable fraction.

The risk of being infected during operation is very low: the triggering conditions for a sprinkler would tend to preclude any unprotected person being in the operational area.

Potential for human infection

The people most likely to be exposed are fire-fighting professionals and FFS maintenance personnel. The potentially exposed people who are most likely to become ill are those in health care premises and people with existing lung disease.

CONTROL OF *LEGIONELLA*

Management system

Incorporate FFSs (especially storage tanks) into any existing site *legionella* monitoring system.

Table 1: Comparison of conditions in fire fighting systems and those required for growth of *legionella*.

Component	Bacteria growth requirements	Pipework & installations	Water supply				
Property			Public mains	Elevated private reservoir	Gravity tank	Automatic pump	Pressure tank
Temperature range	25 - 45 °C	Ambient	Ambient	Ambient	Ambient	Ambient	Ambient
Stagnant water	†	†	✣	†	†	†	†
Contamination							
- Organic	†	✣	✣	?	✣*	✣	✣
- Iron	†	†	†	†	†	†	†
Oxygen	†	✣‡	†	†	✞	✞	✞
Light	†	✣	✣	?	✣*	✣	✣
Bacterial growth	-	✣	✣	?	✣	✣	✣

† - Condition present. ✣ - Condition not present. ? - Condition possible. * See ref. [1]. ‡ Deoxygenated due to rust formation.

Water sampling and treatment

Routine water sampling for *legionella* has generally not been recommended as a method of determining risk, due to the larger importance of the other risk factors discussed above, i.e. the formation and inhalation of aerosols[3].

However, it may be prudent to monitor the water quality on a regular basis (e.g. yearly) using a simple quick bacterial assay such as a dip slide (measures total bacterial concentration, not just *legionella*[4]). Dip slide results with colony forming units per millilitre counts above 100,000 (10^5 cfu/ml) indicate that some remedial action is necessary. To ensure any remedial action is successful, subsequent testing (and any further action required) should be performed at more frequent intervals until bacterial concentration is below 100,000 colony forming units per millilitre.

The preferred method of chemical water treatment for control of *legionella* (or any bacteria) is the use of a biocide such as chlorine dioxide. One of the difficulties associated with biocides is the lack of biofilm penetration and it may be necessary to incorporate a dispersant to assist in the disinfection. The possible effect of chlorine levels on the variety of building materials used in private tanks (e.g. bitumen-lined concrete, steel and plastics) should be considered. It is recommended that any such chemical water treatment is performed by a water testing/treatment consultant.

Other control methods

To help prevent the growth of *legionella*, the FFS tank and piping should be kept cool (< 20°C), i.e. away from any sources of heat such as sunlight, nearby hot water pipes, heating ducts or warm air currents.

To prevent the build-up of nutrients, visual inspection of storage tank condition, including monitoring for rust and internal deposits (e.g. sludge, biofilm), should be performed annually. Internal deposits or any tank deterioration should be corrected.

During testing and maintenance of the FFS, procedures should minimise the production of aerosols and the exposure to persons nearby.

CONCLUSIONS

- FFSs directly supplied with public mains water present no significant risk of infection with *legionella.*
- FFSs supplied with water from poorly maintained private tanks present a theoretical risk of infection with *legionella*, particularly to maintenance personnel, fire-fighting professionals and in health care premises.
- LPC recommended control measures:
  - Incorporate FFS into any existing *legionella* monitoring system for the site.
  - Minimise production of aerosols during testing and maintenance.
  - Maintain tanks and piping at < 20°C by shielding from possible heat sources.
  - Annual inspection of tanks to monitor corrosion and deposit build-up, with appropriate remedial actions.
  - Annual monitoring of water tank bacterial concentration by dip slide. Concentrations above 10^5 cfu/ml indicate that chemical treatment of the water may be necessary.

REFERENCES

1 BS 5306(2) clause 17.3.1.3 - "the tank shall be covered to exclude daylight and solid matter"

2 The control of legionellosis (including legionnaires' disease). ACoP, HSC, London. 1995

3 The control of legionellosis including legionnaires' disease. HS(G)70, HSE, London. 1993

4 HS(G)70, paragraphs 122-5.

5 The control of legionellosis in hot and cold water systems. HS(G)70 supplement, HSE, London. 1998

FURTHER INFORMATION

Minimising the risk of legionnaires' disease. Technical Memorandum 13, CIBSE, London, 1991

Legionellosis. The New England Journal of Medicine, 337 (1997), 682-7.

BS 6068-4.12: 1998 Water quality. Microbiological methods. Detection and enumeration of *legionella*.

BS 7592: 1992 Methods for sampling for *legionella* organisms in water and related materials.

Water testing/treatment consultants can be found in yellow pages

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