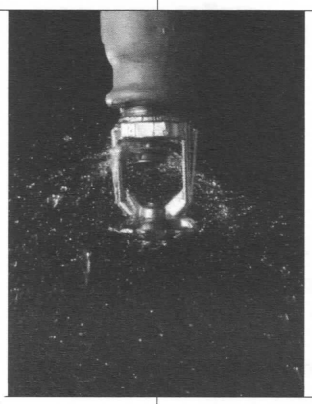

Fire Protection Association

LPC Rules for
Automatic Sprinkler Installations

Legionella and firefighting systems

This Technical Briefing Note is a revised version of a document originally published by the LPC in 1999. It presents a summary of knowledge and practice together with references and sources of further information.

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SUMMARY: Legionellosis

- 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 200 reported cases of legionnaires' disease in England and Wales per year, the mortality rate being about 10-15%. Cases are reported only if there is laboratory confirmation of *legionella.* These cases are usually associated with wet cooling towers for air conditioning systems.
- *Legionella* is present in rivers, ponds and streams and cases of legionellosis are most likely to arise from *legionella* in domestic water.
- Hospitals and care homes situated in the vicinity of cooling towers should identify resident persons potentially vulnerable to legionellosis; some guidance suggests that risks can extend to hundreds of metres.
- Persons responsible for cooling towers in which colonies of *legionella* are shown to exist, by water sampling, may be held to be a breach of the general duty of care.

SUMMARY: Firefighting systems and legionellosis

- The operation of firefighting systems (sprinklers, drenchers and ring mains) may create inhalable water droplets. However, the conditions normally found within well-maintained firefighting systems are not thought able to support the growth of significant populations of *legionella.*
- The risk of catching legionellosis from a properly installed and maintained firefighting system is probably negligible, although this risk may increase for private water supplies, for maintenance personnel and in health care establishments.
- The likelihood of exposure to water mist from, for example, a discharging sprinkler system is very small; it is more likely that exposure will occur during maintenance/testing work involving sprinklers, hoses and water mist systems.
- Suggested control measures:
    - Include the firefighting system within any existing *legionella* monitoring system for a site, not forgetting to test water supplies delivered to hose reels.
    - Minimise production of aerosols during testing and maintenance.
    - Maintain pipes and water storage tanks at <20°C by shielding from possible heat sources.
    - Inspect storage tanks at least once a year to monitor corrosion and deposit build-up, and take appropriate remedial actions.
    - Carry out periodic monitoring of the water tank[1] bacterial concentration by dip slide, at least once a year and particularly in summer. Total bacterial concentrations above 100,000 colony-forming units per millilitre (10^5cfu/ml) indicate that there exists a biological contamination problem and that the system need thorough decontamination.

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 200 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 (≤5μm in diameter) they can pass deep into the lungs where they may be deposited into the terminal air sacs (alveoli).

Open wounds are known to be vulnerable to attack by *legionella*.

Another (theoretical) route of exposure is breathing in of water whilst drinking. There is very limited 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.

Fifty per cent of cases of legionnaires' disease presented in England and Wales are contracted while the victims are abroad and manifest themselves within 10 days.

It is possible to perform exact genetic matching between *legionella* bacteria in the body of the victim and *legionella* in the suspect environment. But all other potential sources must be eliminated.

Persons at a higher risk of infection include:

- Males (who are three times more susceptible than females).
- Adults, particularly those over 50 years (the median age of victims is 55).
- 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°C and 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 multipy 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 practice plus guidance[2] on the subject of controlling *legionella* in water systems is published by the Health and Safety Executive and makes reference to the general duties of employers under the Health and Safety at Work etc Act and the Control of Substances Hazardous to Health Regulations for hazardous micro-organisms. (Other guidance on legionnaire's disease is to be found on the HSE web site[3].) 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 an employee contracts legionnaires' disease, the employer has to report it.

FIREFIGHTING SYSTEMS

Firefighting 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 firefighting 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 an 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 HSE advice[2] is to sample water from every available outlet in a hot or cold water supply system at least once a year, although it fails to mention hose reels or sprinkler systems. Mid-summer would be a recommended time for such testing.)

So the question is, would conditions in an FFS 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, since the infectious dose will depend largely on the method of delivery.

Table 1. Comparison of conditions in firefighting 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.

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. Ponds should be regarded as suspect sources of water supply for FFSs.

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.

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, firefighting professionals and in health care premises.
- Recommended control measures:
    - Include the FFS within any existing *legionella* monitoring system for the site, not forgetting to test water supplies delivered to hose reels.
    - Minimise production of aerosols during testing and maintenance.
    - Maintain tanks and piping at <20°C by shielding from possible heat sources.
    - Inspect storage tanks at least once a year to monitor corrosion and deposit build-up, and take appropriate remedial actions.
    - Carry out periodic monitoring of the water tank bacterial concentration by dip slide, at least once a year and particularly in summer. Concentrations above 10^5cfu/ml indicate that biological decontamination treatment of the system may be necessary, including chemical treatment of the water.

REFERENCES

1. BS EN 12845: 2003, clause 9.6.2(b) – 'there shall be no entry [to the tank] for light or foreign matter' in systems which have what the BS EN describes as 'Superior water supplies'.
2. *Legionnaires' disease. The control of legionella bacteria in water systems.* Approved Code of Practice and guidance, 2nd edition, HSE, 2000.
3. Visit www.hse.gov.uk/legionnaires for downloadable copies of:

   Legionnaires' disease – a guide for employers

   Legionnaires' disease – essential information for providers of residential information

   Legionnaires' disease: controlling the risks associated with using spa baths

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,* British Standards Institution.

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

Water testing/treatment consultants can be found in yellow pages. Some companies offer test kits comprising equipment, reagents and instructions for use to detect the presence and levels of *legionella* in water systems.