Legionella Risk Management in Mining and Processing Industries

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ABSTRACT
Legionella risk management for mining operations represents a growing area of concern, particularly in view of some recently publicised cases at Northern mines. There appears to be some disparity between various OH&S and Health authorities approach to Legionella risk-management where either control measures may either insufficient, disproportionate, irrational or not relevant to the application. This is due in part to the focus of current Australian Standards for Legionella management being on cooling tower and evaporative condenser units. That is, currently there are no common guidelines or standards that address management of other Legionella hazards in mining and related industries. Risk sources identified include recycled and natural source waters utilized in dust-suppression, drilling, vehicle wash-down and irrigation as well as potable reticulation systems.

The context of this presentation will be based on our consulting laboratory's experience in mining and industry operations. Possible Legionella risk sources and their downstream consequences will be identified. System performance monitoring, risk management principles and control strategies, will be presented in relation to ensuring the best possible outcomes as well as response times.

INTRODUCTION

Brief Background:

The first reported incidence of legionellosis dates back to 1976 where approximately 200 people became ill after attending an American Legion convention in Philadelphia (1). Ultimately 34 people died from exposure to a mysterious organism. A year later a type of bacteria was identified and attributed to the cause of the disease. In honour and memory of the conventioneers the illness it causes (pneumonia) the bacterium was named *Legionella pneumophila*.

Current Knowledge

It is now known that the bacterium requires, water, warm temperatures (typically 30-50C), a food-source and a potential protozoan host (amoeba) to multiply (2). They are ubiquitous in many aqueous freshwater and brackish water environments and have also been found in moist soils (including commercial potting mixes).

Infection and Disease

Infection usually occurs by inhalation of *Legionella* containing aerosols. It is not clear what percentage of infected persons actually exhibit symptoms which may range from severe pneumonia accompanied by multiple organ failure to a short, influenza-like illness. The current fatalities among people who develop *Legionellae* mediated pneumonia is cited as ranging between 15 and 50% in Australia (1, 6). It appears that 3-5% of all pneumonia cases submitted to Australian hospitals suffer from legionellosis.

Virulence Life-style factors (7)

Factors which contribute to the virulence of the infection process includes:

- The virulence of the Legionella strain (19 out of 50 species are virulent)
- Size of the "Inoculum" (number of virulent cells)
- Immune status and age of the infected individual
- Life-style and general health of the individual

Typically, Legionella mediated pneumonia develops in individuals who are:

- Above 50 years old,
- Males
- Smokers
- Heavy alcohol intake
- Impaired immune system (pharmacologically induced or naturally low)

IDENTIFIED LEGIONELLA SOURCES AND RISK EVENTS ON MINE SITES

During a period spanning approximately 6 years including numerous site inductions our staff identified a number of Legionella sources and environments suitable for Legionella growth throughout mine-sites located north of the Tropic Of Capricorn. Most sites were assayed within a framework of establishing site-based water quality management plans which included Legionella risk management.

Table 1: Potential Legionella Sources on Mine Sites and Examples of Typical Maximum Counts (source: Enviro-Check Laboratory Results: 2001-2007)

Potential Legionella Bacteria Growth Sites	Applicable Standard	Typical Maximum Counts
Air-conditioning Cooling Towers – Evaporative Types	AS/NZS 3666	10^1-10^2cfu/ml
Industrial Cooling Towers – Evaporative Types	AS/NZS 3666	10^1-10^2cfu/ml
Hot Water Systems (eg bath house)	AS/NZS 3500.4:2003	10^1-10^2cfu/ml
Water-based Cutting Fluids	n.a.	10^1-10^2cfu/ml
Stagnant Bodies of Water (particularly underground)	n.a.	**10^2-10^3cfu/ml**
Large Pipe Networks – Particularly in 'Dead Legs'	n.a.	**10^2-10^3cfu/ml**
Safety Showers	n.a.	10^1-10^2cfu/ml
Mining Camp Spa-Pools	AS HB 241-2002	None-detected
Sprinkler Systems (eg Dust suppression Systems)	n.a	**10^2-10^3cfu/ml**
Wash-Bay Water Systems	n.a.	**10^1-10^3cfu/ml**
Fire Water Systems	n.a	10^1-10^2cfu/ml

Current Regulated Risk Management Efforts

Typically risk management efforts appear to be to be highest for risk events covered by a particular Regulatory Standards or Guideline.

If potable water is used it is generally governed by the Australian Drinking Water Guideline (ADWG-2004). Although this standard does not cover Legionella risks, the recommended treatments to reduce general microbial pathogens will also affect legionella organisms. As mentioned above, skin or oral infections have not been reported (8) and therefore the consequences of Legionella detection in waters for potable use are usually ranked low.

Cooling tower legionella-risk management in Queensland is strictly regulated via the AS/NZS 3666 standard series (2,3,4,5). These standards prescribe drift eliminators, the wearing of PPE, routine water treatment services, inspections and regular sampling for Legionella and heterotrophic plate counts. In addition to standard PPE, staff with authorized access to the cooling towers usually wear P2-face masks. The location of the cooling tower is also important, preferentially located out of spray-drift reach to nearby work-shops and thoroughfares. If this is not-the case and the spray-drift is likely to reach a large number of site-workers the probability of inhalation and infection increases substantially.

Spa legionella-risk management in Queensland is regulated via the AS HB 241-2002 (11). This Australian Standards handbook provides the mine site grounds-men with guidelines to compliant water treatment, water quality monitoring, sampling, data logging and trouble shooting. The consequences of Legionella detection in spas are ranked high at third place due to unrestricted regular access of most staff and regular reported cases in Queensland.

Non-regulated Risk Management Efforts

Waters sourced for dust suppression, drill-sprays and high pressure wash-down bays have been documented to exhibit the high frequencies and counts for legionella detection (ref. NATA certified laboratory test results; Enviro-Check Enterprises 2001-2007). Typical feed-water sources analysed included recycled industrial water dams, non-treated water piped over long distances in exposed pipelines reaching temperatures above 30C, pooled underground surface water and recycled mine water. Accumulating evidence monitoring evidence throughout Northern and Central Queensland suggests that (at least in tropical regions) significant viable Legionella bacteria numbers are found in non-regulated sources utilized in aerosol generating processes.

Comparison of Risk Event Management

A direct comparison of applicable risk-management efforts (see table 2) suggests that qualitative and/or quantitative risk assessment procedure infer an overall higher risk to some non-regulated rsources, since current risk management practices focus on regulated plants and equipment. Regular water treatment and monitoring, restricted access, isolated physical locations and prescribed PPE of maintenance workers will decrease event frequencies and the severity of consequences considerably.

To the best of our knowledge no published data is available which directly compares Legionellosis incidences and their infection sources on mine sites and infection events are generally assumed to be related to regulated sources. Positive identification of the infectious source would require genotype comparison and the application of Legionella DNA-fingerprinting techniques. Although these techniques are well developed, no record was available to us which indicates that they have been employed in Legionellosis investigations in Queensland Mine sites. In view of this lack of evidence it is advisable to adopt a precautionary approach which includes both, regulated and non-regulated sources in site based Legionella risk management plans.

Table 2: Comparative Risk Management –Regulated Versa Non-Regulated Sources

Legionella Bacteria Detected in Traditionally Regulated Growth Sites	Standards Applicable	Typically Equipped with physical and chemical barriers	Regularly serviced	Regularly Monitored
Eg. evaporative condensers, cooling towers, hot-water systems, spa-poools	Yes	Drift eliminators, biocide treatment, filtration	Weekly, monthly	Weekly, monthly

VERSA

Legionella Detected in Non-Regulated Growth Sites	Standards Applicable	Typically Equipped with physical and chemical barriers	Regularly serviced	Regularly Monitored
Eg. non-treated recycled water, surface water, reticulated water	No	No	rarely	rarely

Likelihood of Consequences

Likelihoods of the possible consequences are often neglected in many well publicised risk events/hazards which generate a certain degree of fear and public out-rage. Often the probabilities of the risk events are far greater than the probabilities of the risk event consequences. If an event raises sufficient “public outrage” such as, for example the detection of *Legionellae* in cooling water the probability of the possible consequence is often neglected in a potential consequence/outcome analysis and risk levels are often categorized as catastrophic.

Frequently responses to these often highly publicised cases are often disproportional large and focused on the event probabilities resulting in a perceived high risk. Whereas the “calculated risk” levels are much lower when one takes into account the relatively much lower likelihood of the possible consequences and multiplying these with the event probabilities. In the case of Legionella detection the actual consequence probabilities of infection and developing symptoms and resulting risk levels would be lower if one were to take into account the influence of virulence and life-style factors on the probability of actual developing symptoms (see above). However precautionary principals should prevail when conducting a risk assessment for a site-based legionella management plan and at least initially, the hazard identification step should include water uses on site where the workforce is potentially exposed to inhalable aerosol.

Site Based Legionella Risk Management

To comply with due-dilligence and maximize duty of care a site-based Legionella management system needs to ensure that no site personnel or visitor is exposed to potentially infectious legionella containing aerosol from whatever sources there may be present on a site. A site Based Legionella Management Plan typically includes:

- Summary of regulatory requirements; site policies for raw, treated and recycled water policies;

- Intended uses and sources of recycled water, raw and treated waters used in aerosol generating processes
- Assessment of existing or baseline water quality data of these waters
- Hazard identification and risk assessment
- Current and existing preventative measures and barriers to manage risks to human health
- Identification of critical control points
- Current and proposed operational procedures and process control; operational monitoring
- Corrective actions (current; proposed) with regards to aerosol exposure and human health
- Current equipment capabilities and maintenance schedules
- Documentation of past, current and proposed verification data (monitoring health and environmental parameters)
- Track record, compliance data, exceedances, incidence management
- Documentation and reporting of operational performance and compliance monitoring
- Review and continuous improvement strategies

A legionella containing water source involved in aerosol generation is a potential hazard and needs to be managed. For most non-regulated sources and activities, best practice is currently applied in the form of adopting the AS/NZS 3666 series and AS/NZS 5059 cooling-water standards.

Critical risks that require attention in the framework of these standards are:

- Stagnant water and biofilm formation potential
- Nutrients and temperature factors
- Track records of Legionella concentrations (raw water sources, supply infrastructure, point of use)
- System deficiencies in aerosol control
- Location and access

Typical control strategies and corrective actions applied in the framework of these standards are:

- Alternative water supply sources and redundancies for high risk uses
- water treatment of source and process waters
- on-line disinfection according to appendix B (AS/NZS 3666.3:2000)
- on-line decontamination according to appendix C (AS/NZS 3666.3:2000)
- access restrictions and PPE (eg. minimum P2-dust mask (Handbook HB32 SAA/SNZ 1995)

Due Dilligence, Duty of Care and “Murphy’s Law”

A site specific design and implementation of a legionella risk management plan demonstrate a proactive approach to control legionella risks. It assists with clearly defined

corrective action guidelines in the case of hazard identification, hazard control and incident management therefore assisting with a company's due diligence and maximizing duties of care to it's employees.

The legionella bacterium is an ubiquitous organism and the "Murphy's Law" chance of personnel contracting the pathogen at a site which is totally unrelated to it's work place provides an additional scenario for concern. Once diagnosed with legionellosis, the person becomes a "Reportable Incidence to Queensland Health and will most likely precipitate a work-place site audit, document desk audit, attract media scrutiny and a series of corrective actions. A solid track record of compliant, well documented Legionella monitoring and corrective action data documented will significantly reduce a business risks in preventing an often unnecessary shutdown and evacuation of the work-force.

Communication

Site-based Legionella management systems typically include a formalised chain of communication procedure with a laboratory, regulatory authority, OHS and supervising personnel. Some risk management plans also include routine internal news-letters and trends on the current Legionella status of cooling towers, storage sources and a history of corrective actions. Annual OHS-presentations on Legionella risk-management reviews and general Legionella information will generally educate the site staff to differentiate between the " perceived " versa "real" risks. Past experiences have demonstrated that an informed work-force will generally reduce the likelihood of Legionella related work-force hysteria and assist with rational judgements on corrective actions in response to non-compliances.

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