KOGAN CREEK PROCEDURE FOR

RISK MANAGEMENT PLAN – LEGIONELLA CONTROL
KA-CHM-22

Responsible Officer: Station chemist
Responsible Manager: Kogan Creek General Manager
Responsible Executive: Executive General Manager of Production

DOCUMENT HISTORY

Key Changes	Prepared By	Checked By	Approved By	Date
Created (12/04/2010)	K Rose			
Reviewed (27/09/2016)	K Rose	B Gothmann	J Edwards	05.10.2016
Included reference to Clarifier and updated anti-scalent information (18/07/2019)	L Smith	K Rose	T Danby	30.07.2019

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1 PURPOSE

The purpose of this document is to establish water treatment, maintenance, monitoring and control guidelines for minimizing the possibility of outbreaks of legionnaire's disease, thereby protecting the health and safety of workers and visitors at Kogan Creek Power Station. Water sources on the station have been considered and a risk assessment completed. A risk management plan has been developed and is presented in this document.

2 SCOPE

This document applies to Kogan Creek Power Station, including the power generation plant, ancillary systems and general grounds.

3 INTRODUCTION

The presence of *legionella* bacteria in water system, soils and other media can present a risk of the development of Legionellosis to susceptible individuals who are exposed to the bacteria. Legionellosis may take one of two forms:

Legionnaire's Disease – an acute bacterial infection of the lower respiratory tract with flu like symptoms and Pneumonia. Legionnaire's disease can be fatal.

Pontiac Fever – Respiratory illness with influenza like symptoms (without Pneumonia).

Both *legionella pneumophila* and *legionella not pneumophila* species are known to cause infection in humans, although mostly the *legionella pneumophila serogroup 1* is responsible for Legionnaire's disease[2].

Both forms of Legionellosis are caused by inhalation of tiny airborne droplets (<10µm) containing the *legionella* bacteria. The risk of developing Legionellosis is increased by individual factors including;

- Poor health
- Immuno-compromised individuals
- Smoking
- Age
- Concentration of *legionella* bacteria in the air and length of time a person is exposed to a contaminated aerosol

Legionella bacteria are very widespread in the environment, occurring in soils and natural fresh water systems. It proliferates in the presence of sludge, scale, rust, algae and, most importantly, in water temperatures in the range of 20°C to 45°C. Such conditions are most likely to occur in cooling water systems at Kogan Creek Power Station, but also domestic water and raw water supplies.

Because Kogan Creek Power Station has a continuously monitored biocidal dosing system and conducts regular maintenance and monitoring of its cooling water system the risk of contracting Legionellosis is considered low.

4 RESPONSIBILITIES AND ACCOUNTABILITIES

4.1 Management

Management are responsible for ensuring that:

- This management plan is maintained to legislative and corporate requirements; and

- Periodic reviews of this management plan are undertaken

4.2 Employees

Employees are responsible for ensuring that:

- Following the guidelines in this management plan;
- Notifying the Responsible Officer of any changes identified to the plant or processes specified in this management plan, for a review to be instigated; and
- Being involved in the review process when requested to by their Supervisor or Manager.

4.3 Contractors / Consultants

Contractors / Consultants are responsible for ensuring that:

- Following the guidelines in this management plan.

5 ACTIONS

5.1 Identification of potential *legionella* sources at Kogan Creek Power Station

Table 1 illustrates the water sources on CS Energy Kogan Creek Power Station property that potentially contain *legionella* bacteria.

Table 1: Kogan Creek Power Station Water Sources

Water Source	Description and location
ACW (Auxiliary Cooling Water)	The ACW tower is located at the south eastern side of power station between the laboratory and waste water collection pond. The heat exchangers are located at the eastern side of the turbine hall. The function of the ACW system is to cool the closed cooling water system.
SCC (Submerged Chain Conveyer) Cooling Water Pond	SCC cooling pond is located at the far south eastern end of the power station. The SCC is located under the boiler and the SCC drain pit is located between the SCC and the water treatment plant. The SCC removes the bottom ash from the boiler and is submerged in the cooling water.
Kogan Pond (AKA Northern Raw Water Pond)	The Kogan pond is located at the north eastern end of the power station. It is used to supply fire fighting water.
Lagoon Gully Pond (AKA Southern Raw Water Pond)	The lagoon gully pond is located at the south western side of the power station. It supplies makeup water to the auxiliary cooling tower as well as raw water to areas in the demin plant and boiler house.
Service Water	The service water tank is located south of the water treatment plant. Service water is used to feed the demineralisation plant and is used in the boiler house.
CCW (Closed Cooling Water)	The CCW is a ‘clean” water system and provides cooling to various auxiliary plant in the turbine hall and boiler house. The system is closed and not open to atmosphere.

Water Source	Description and location
DRD (Drains Reclaim Dam)	The DRD is located north east of the station outside the boundary fence. It is pumped back to the station for use in the ashing system. It is also clarified to feed into the Cooling Tower and Lagoon Gully Pond.
WWCP (Waste Water Collection Pond)	The WWCP receives waste water from the demin plant, RO (Reverse Osmosis) plant, cooling tower blowdown, sewage treatment plant, oily water separator, plant drains, Lagoon Gully pond, DRD reclaim and SCC cooling pond.
NSWD (Northern Storm Water Dam)	The NSWD collects storm water runoff from the western half of the power station site. It is used for irrigation purposes around the security hut and administration building.
SSWD (Southern Storm Water Dam)	The SSWD collects storm water runoff from the eastern half of the power station site and overflow from the DRD. It is not reclaimed for reuse on site.
IADA SWD (Initial Ash Disposal Area Storm Water Dam)	The IADA SWD collects storm water runoff from the Initial ash disposal area. The water is reclaimed to the SCC cooling pond or the WWCP.
OPAC (Out of Pit Ash Cell) reclaim	The OPAC receives the bulk of the ash slurry produced by the power station. Water seepage from the slurry collects into the lined base of the OPAC and is reclaimed for ashing.
Domestic water and hot water systems	Domestic water is supplied to the laboratory, workshop, stores, fire station, security, control room, boiler house, administration building and the mine.
Air conditioning systems	Large air conditioning units are located at the admin building, stores, laboratory and control room annex.

The following water sources have not been given further consideration in this document as there is considered to be no risk of inhaling *legionella* contaminated aerosols.

- The air conditioning systems at Kogan creek Power Stations do not utilise wet cooling towers and the humidification systems are of a boiling – steam injection type.
- SSWD – the southern storm water dam is used only for water storage and as such does not form any aerosol from which people could inhale

5.2 Risk Assessments

The risk assessments were conducted with reference to AS 5059-2006: Power station cooling tower water systems – Management of legionnaire's disease health risk. CS Energy's JSEA template and risk matrix was used to conduct risk assessments of all the water sources where potential aerosol formation could occur. A summary of the overall classifications for each water system on site is presented below in Table 2.

Table 2: Risk Assessment Summary

Water System	Risk rating before control measures	Control measures in place	Residual risk rating
Auxiliary cooling water and cooling tower	Significant	Yes	Low
SCC cooling water	Moderate	Yes	Low
Kogan Pond	Low	Yes	Low
Lagoon Gully Pond	Low	No	Low
Service water	Low	No	Low
Closed Cooling water	Low	No	Low
Drains reclaim Dam	Low	No	Low
Waste Water Collection Pond	Low	No	Low
Northern Storm Water Dam	Low	No	Low
IADA Storm water run-off dam	Low	No	Low
Domestic water	Moderate	Yes	Low

5.3 Risk Management

5.3.1 Auxiliary Cooling Water System

The Auxiliary cooling water system poses the most risk to personnel as a source of *legionella* bacteria. The risk assessment found the uncontrolled risk as significant. The auxiliary cooling water (ACW) system at Kogan Creek Power Station is an open recirculating system with a 3-cell wet cooling tower, refer to Figure 1. The design of the tower is such that during normal operation 2 cells are in service and 1 on standby. The standby cell will come into operation with the wet bulb temperature rises above 26.5°C to keep the cold water temperature below 33°C. The purpose of the auxiliary cooling system is to absorb and subsequently cool the heat transferred from the closed cooling water systems (CCW) 2 of 3 plate type heat exchangers, refer to Figure 2.

The auxiliary cooling tower is an induced draft design and consists mainly of the cooling fill, the water distribution, the drift eliminator and fan drive unit. The ACW is uniformly spread over the cooling fill by the water distribution system. The splash fill used is designed to break the mass of falling water into a large number of droplets, thus increasing the water surface area exposed to the counter current cooling air for maximum cooling. The drift eliminator mounted above the water distribution separates the water droplets carried away by the air stream. Some useful system design data is listed below

Recirculation Rate	940kg/s
System Volume	700m^3
Operation hrs	24hrs, 365days/year

Materials of construction	Concrete
	Lined steel
	Fibre glass
Heat exchanger construct	Titanium plate

The areas of the ACW that are deemed to present a *legionella* hazard are any areas where misting (small water droplets) or an aerosol of the cooling water may be formed. Under normal operating conditions the cooling tower is likely to be the major source of mists and aerosols, however other areas may include (but are not limited to) leaking pipe work, connections, fittings, drains, heat exchangers and sample lines. Under abnormal operating conditions or even when the ACW system is out of service all of these areas and others may present a *legionella* hazard even though the system may not be operational (eg when cleaning the ACW/CCW heat exchangers the risk of Legionellosis must still be managed).

Figure 1: ACW Cooling Tower

Figure 2; ACW/CCW Heat Exchangers

5.3.1.1 Water Treatment Control Measures

The ACW system at Kogan Creek Power Station undergoes a closely monitored chemical treatment program, which involves the addition of two antiscalents and a biocide. Details of the chemicals and dosing targets are illustrated in table 3 below.

Table 3: Chemical Treatment Program

Chemical	Function	Target
NALCO 3DT138 with TRASAR	Hardness and Silica stabiliser, acts by inhibiting crystal growth	5 ppm
Sodium hypochlorite/ sodium bromide	Sodium hypochlorite and sodium bromide are mixed pr injection. The most active biocidal activity is from hypobromus acid.	0.3ppm
CoC	Cycles of concentration	2.6 when make-up is from Lagoon Gully Pond. When make-up is from clarifier Conductivity of 2500µS/cm is used (~10 CoC)
NALCO Stabrex ST70	Proprietary biocide to be used as a backup in case normal biocide dosing is disrupted.	0.3ppm

Stagnation

The auxiliary cooling system operates continuously and complete shutdowns are rare and would only occur during an overhaul. Dead legs exist in the system as there are only 2 of the 3 ACW pumps running and 2 of the 3 heat exchangers running under normal operating conditions. A routine program for the changeover of duty and standby pumps and equipment is implemented.

Nutrient Availability

The Auxiliary cooling water system operates at low cycles of concentration, which is advantageous to limiting the accumulation of nutrients. Continuous, automatically controlled biocide dosing helps limit the build-up of bio-films which harbor and protect *legionella* bacteria. The closed deck design of the cooling tower limits the number of wetted surfaces exposed to sunlight.

Water Quality

The presence of protozoa and algae is controlled by the continuous dosing of biocide to a free chlorine residual of 0.3ppm, which is measured continuously by an online chlorine analyser. Continuous dosing was chosen as opposed to intermittent dosing to give longer contact times. This increases the effectiveness of biological control as the pH of the cooling water is high. Scale in the system is controlled by the continuous addition of an anti-scalent to control both calcium hardness scale and silica scale. The dosing of anti-scalent is controlled by makeup water flow and direct measurement of 3DT 138 using TRASAR® technology. Suspended solids are controlled well in the system due to the limited cycles of concentration the tower operates at. The CoC is calculated using the conductivity of the raw water makeup and the conductivity of the ACW water, which are measured continuously by online conductivity meters. The ICMS controls the CoC to set point by adjusting the blowdown valve control position. The chemical section staff currently re-stocks chemicals, adjusts dosing and maintains all online instrumentation. Samples are regularly taken from the ACW and raw water makeup and analysed according to the following schedule (table 4) by the Kogan creek Laboratory. This includes monthly samples for HPC and *legionella* monitoring.

Table 4: Sampling and analysis schedule

Parameter	Weekly		Monthly		Target Values ACW
	ACW	Makeup Water	ACW	Makeup Water	
pH	✓	✓	✓	✓	Trend
Conductivity	✓	✓	✓	✓	Trend
Turbidity	✓	✓	✓	✓	Trend
Suspended solids	✓	✓	✓	✓	<50mg/L
Ion balance			✓	✓	± 5%
Free and total chlorine	✓		✓		0.3ppm free
Hardness Ca, Mg & total	✓	✓	✓	✓	Trend
Silica			✓	✓	Trend

Parameter	Weekly		Monthly		Target Values ACW
TDS (total dissolved solids)			✓	✓	Trend
HPC (hetrotrophic plate count)*			✓		<100,000CFU
Legionella pneumophila*			✓		<10CFU
Legionella not pneumophila*			✓		<10CFU

*analysed by a NATA accredited laboratory

The results are recorded in a database; TRIM reference K/D/11/2251

5.3.1.2 Other Control Measures

Permanent signs have been erected on the wall of the ACW cooling tower warning of the possible *legionella* hazard, figure 4. Temporary signs can also be placed outside the ACW cooling tower in case of a confirmed outbreak of *legionella* bacteria, figure 3.

Figure 3: T**emporary Signage**

Figure 4: Permanent Signage

5.3.1.3 Requirement for Entry into the ACW Cooling Tower

Occasionally for maintenance or inspection reasons entry into the ACW cooling tower is required, which presents the highest risk of exposure to *legionella* bacteria. A P2 mask must be worn as a minimum level of respiratory protection and a JSEA completed. CS Energy also requires personnel to do a Cooling Tower Induction and a Cooling Tower Access Health Statement, form S1844, before entry. The purpose of the form is to exclude individuals from entry if they are deemed unfit. Kogan Creek Procedure - H&S - KA-OHS-08 - Auxiliary Cooling Tower Entry - (07/16) - Kogan Creek Registered details the requirements for entry into the ACW tower.

5.3.1.4 Requirements for Cleaning of ACW/CCW Heat Exchangers

A JSEA is required to be completed before cleaning of the ACW heat exchangers can begin and should include control measures to limit the exposure to any aerosols generated. A P2 mask is recommended.

5.3.2 Submerged Chain Conveyor (SCC) Cooling System

The SCC cooling systems comprises the cooling water system for the submerged chain conveyor (SCC). This system includes the SCC itself, the cooling pond, the cooling water pit and all of the associated pipe work, pumps and ancillary equipment. The SCC cooling system may present a *legionella* hazard. It has been observed that the cooling water pit, illustrated in figure 5, can produce mists and aerosols which may contain *legionella* bacteria. An area of the SCC cooling system where mists and aerosols are present should be regarded as hazardous.

Figure 5 SCC cooling water pump pit

5.3.2.1 Control Measures

There is currently no chemical dosing to reduce bacteria or *legionella* levels in the SCC cooling system. The risk of exposure from this source is considered to be low because of limited access. Signs have been placed near the pit, illustrated in figure 5 above, to warn people of the potential hazard and to recommend a P2 mask be worn if working in the immediate vicinity. A sample of SCC cooling water,

collected from the SCC cooling pond, is taken monthly and analysed for HPC and *legionella* to monitor for outbreaks of the bacteria.

It is recommended a risk assessment is carried out before any work or access to areas of plant where *legionella* may present a hazard occurs. The risk assessment should include the requirements of any Personal Protective Equipment (PPE) that is required to safely access the area. As *legionella* presents a hazard through inhalation, respiratory protection is usually required, with the minimum level of protection being the use of a P2 mask.

5.3.3 Domestic Water

Domestic water is produced on site at Kogan Creek from a mixture of Kogan Bore water and Demineralised water. The water is chlorinated to a free residual chlorine of 1.0ppm and is constantly recirculated in the domestic water tank. This ensures there is a >0.3ppm free residual chlorine at the furthest point of use on site which is the administration building.

5.3.3.1 Stagnation

The domestic water pumps are fitted with a minimum flow valve which continuously circulates the water in the tank preventing stagnation. Sodium hypochorite is dosed into this recirculation line to maintain a free residual chlorine of 1.0ppm. The free chlorine is measured continuously by an online analyser along with pH. The ICMS uses this value to automatically dose the system. Some branches of the domestic water distribution system are used more than others and some dead legs may exist.

5.3.3.2 Nutrient Availability

The presents of nitrogenous nutrients is low as the domestic water is made from a combination of bore water, which has little nitrogen (0.5-1.0ppm), and demineralised water. The domestic water system is completely enclosed and is not exposed to sunlight

5.3.3.3 Water Quality

Suspended solids and scale are minimal within the system. At the point of production the domestic water is chlorinated and passes through a contact vessel to maximise the contact time. The water then passes through a carbon filter which removes the chlorine, trihalomethanes (THMs) and other organic compounds. The water is re-chlorinated once inside the storage tank via the minimum flow line as discussed previously.

The domestic water is monitored weekly for pH, conductivity, turbidity and free and total chlorine. The free and total chlorine is also monitored at the laboratory lunch room, control room, workshop lunch room and administration building. Once a month a full ion balance, HPC, total and faecal coliforms analysis is performed. The results are stored in a database TRIM reference. K/D/11/2257 Testing for *legionella* bacteria is performed 6 monthly and also includes the hot water showers at the administration and laboratory buildings.

5.3.3.4 System Deficiencies

Aerosol generation occurs mainly whilst using the showers at Kogan Creek but will also occur when using domestic water for hosing. The risk of *legionella* bacteria proliferating in the domestic water system is considered low due to the lack of nutrient and the automated chlorine dosing system. The system is also closed which prevents contamination.

5.3.4 Other Water Sources at Kogan Creek Power Station

The remaining water sources on site listed in Table 2 are not discussed in any further detail in this section as they are deemed to be low risk as a source of airborne *legionella* bacteria. As a consequence there are minimal or no control measures in place to control *legionella* bacteria in these water sources

5.4 Monitoring for *legionella* Bacteria and Recording Results

Monitoring of *legionella* bacteria levels is undertaken monthly in the ACW system and the SCC cooling system. Due to the nature of the *legionella* sampling and testing, results should only be used as a guide. Bacteria populations can increase extremely rapidly, while the *legionella* test generally takes about 10-14 days to complete, thus bacteria levels can be significantly different to the reported value by the time results are received. Samples are collected according to standing instruction KC-EI-27 *legionella* sampling. Results are available on request from the station chemist. A summary of the *legionella* monitoring program at Kogan Creek Power Station is presented below in table 5

Table 5: *legionella* Monitoring Program

Sample	Frequency of *legionella* Sampling
Auxiliary cooling water	Monthly
SCC cooling Pond	Monthly
Domestic water	6 monthly
Hot water showers	6 monthly
SCC Washdown hose	6 monthly

The results are recorded in a database TRIM reference. K/D/11/2257

5.5 Management and Reporting of Positive Results

A positive *legionella* result, i.e. >10 CFU/mL requires immediate remedial action. A procedure for dealing with *legionella* outbreaks and the actions required are detailed in standing instruction CHM - KA-CHM-09 managing positive *legionella* results.

A positive *legionella* result shall be reported as a health and safety incident using CS Energy's Incident reporting system via the SAP portal.

Any cases of site personnel contracting Legionnaires disease are required to be reported to Queensland Health and must be recorded as a category 3 incident and investigated accordingly.

6 DEFINITIONS

Term	Definition
ACW	Auxiliary Cooling Water
Aerosol	Airborne particles <10µm in diameter
Biocide	A physical or chemical agent that kills bacterial and other microorganisms
Blowdown	The removal of water from a system to limit the concentration of dissolved salts and suspended solids
CCW	Closed Cooling Water

Term	Definition
CoC	Cycles of concentration
CFU	Colony Forming Units
HPC	Hetrotrophic Plate Count
DRD	Drains reclaim dam
IADA SWD	Initial ash disposal area stormwater dam
NSWD	Northern stormwater dam
SSWD	Southern storm water dam
OPAC	Out of pit ash cell
WWCP	Waste water collection pond
TDS	Total dissolved solids
JSEA	Job Safety and Environmental assessment
ICMS	Integrated control and monitoring system
P2	A half face mask that is used for protection against mechanically or thermally generated particles (as per AS 1715:2009)
PPE	Personal Protective Equipment
ppm	Parts per million
THMs	Trihalomethanes
Ca	Calcium
Mg	Magnesium

7 REFERENCES

Reference No	Reference Title	Author
	AS 5059-2006 Power station cooling tower water systems-Management of legionnaires disease health risk	Standards Australia
	National Environmental health Forum, Guidance for the control of *Legionella*, Water Series No 1, 1996	
	Workplace health and Safety Queensland, guide to *Legionella* Control in Cooling Water Systems, including Cooling Towers, 2013.	Queenland Government
	AS/NZS 3666.3:2011 Air-handling and water systems of buildings-Microbial control. Part 3: Performance-based maintenance of cooling systems	Standards Australia
	NALCO, Program Administration manual, CS Energy Kogan Creek Power Station, Auxiliary Cooling Water Treatment Program	NALCO
K/D/16/996	Procedure - H&S - KA-OHS-08 - Auxiliary Cooling Tower Entry - (07/16) - Kogan Creek Registered	CS Energy
K/D/16/2565	KOGAN CREEK - Auxiliary Cooling Tower Induction - February 2016	CS Energy
K/D/10/3017	Procedure - CHM - KA-CHM-09 - Managing Positive Legionella Results - (Previously KC-EI-26) - (P2) - (10/12) - Kogan Creek Registered	CS Energy
K/D/10/3018	Procedure - CHM - KC-EI-27 - Legionella Sampling - (P4) - (08/10) - Kogan Creek Registered	CS Energy
K/D/16/14773	JSEA - KA10G – Risk assessments for presence of legionella bacteria in site water sources - October 2016	CS Energy

8 RECORDS MANAGEMENT

In order to maintain continual improvement, suitability, safety and effectiveness of the organisation, CS Energy's registered documents will be reviewed on a two yearly basis or at intervals specified by legislative or regulatory requirements. Review of controlled documents should occur where it has been identified that there are changes in technology, legislation, standards, regulation or where experience identifies the need for alteration to the content. Registered documents should also be reviewed following an incident, change management process, modification or where directed as part of a risk assessment process.

CS Energy must ensure that records are retained according to accountability, legal, administrative, financial, commercial and operational requirements and expectations. In compliance with records retention and disposal, all documentation created in relation to CS Energy business must be retained in line with minimum retention periods as detailed in legal retention and disposal schedules.