THE WATER MANAGEMENT SOCIETY

Initial Guidance for End Users on Remote Temperature Monitoring Systems - Part One

Considerations for implementation of systems

Guidance produced by
Water Management Society Working Party

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Introduction to Remote Temperature Monitoring for Legionella Control

1. This document is intended to offer guidance to end users and dutyholders on the principles to consider in the selection and use of a remote temperature monitoring system, in hot and cold water systems, for the purposes of assessing the effectiveness of the control of Legionella and other waterborne pathogens within those systems, where appropriate. This document does not cover interpretation of the data gathered, control settings or competencies required. Additional guidance will be provided on these topics in separate documents, until then we suggest you access competent help and advice from independent experts.

2. It should be noted that remote monitoring may not be appropriate for all systems and manual monitoring may be preferable for some systems.

3. There are legal requirements for the control of Legionella in the Health and Safety at Work etc Act 1974 (HSW Act), Control of Substances Hazardous to Health Regulations 2002 (as amended) (COSHH) and Management of Health and Safety at Work Regulations 1999 (MHSWA) the Approved Code of Practice L8 2013 (ACoP L8). HSG 274 2014 Guidance develops this into practical advice on the legal requirements above, and example methods for the control of risks arising from exposure to Legionella. The use of remote monitoring techniques is mentioned only briefly in HSE guidance (Paragraph 2.53 of HSG274 Part 2), but its use does fall within the principles of ACoP L8 as a valuable tool to identify growth temperatures and water stagnation. Whatever method is used to monitor control measures, it remains the responsibility of the dutyholder to manage the risk.

4. Legionella can grow in water systems between 20°C and 45°C, especially where there is a risk of stagnation. Avoiding this temperature range in as much of a water system for as much of the time as possible is the principal control measure in many Legionella control regimes. Traditional periodic manual checking of temperature at outlets or on the surface of pipework may give some assurance that the system is performing as it should, but does not reflect continuous or representative water system temperatures. Additionally, manual thermal profiling during Legionella risk assessments will inform on the system risk at that point in time only.

5. The main difference between manual monitoring and remote monitoring is the frequency of measurement. It is possible to configure remote monitoring systems to take a reading every few seconds, minutes or hours automatically, rather than the monthly measurement normally taken manually. This frequency of measurement can show how systems perform over a period of time, when in use and at rest. It may also allow identification of water movement by detecting rapid temperature changes in the water system and therefore facilitate management of stagnation by flushing based on evidence of little or no use, thus reducing wasted water.

6. Remote monitoring systems generally use sensors, which relay information to a logging system. The sensors are installed, normally as contact probes directly on suitable pipework, and data should be read at a chosen frequency based on the written scheme of control. Immersion probes are also available but are more difficult to install in existing pipework.

7. There may be two distinct uses for an installation of remote monitoring:

- Temporary installation
  - Commissioning a building
  - Legionella risk assessment
  - Troubleshooting where issues are detected by other means
  - Verification of remediation works
  - Temperature profiling for defects during liabilities period
  - Identify inadequate movement/stagnation
- Permanent installation
  - Replace more traditional temperature monitoring (manual or building management systems (BMS))
  - Partially replace more traditional temperature monitoring
  - Complementary to more traditional temperature monitoring

Proportionality – Is this appropriate for me?

8. There could be a number of reasons why these systems might be advantageous, but there are questions and considerations to take into account before making that decision. Remote monitoring may not be appropriate for all systems and manual monitoring may be preferable for some systems.

9. When considering whether or not to use a remote monitoring system, the question of whether its application is warranted arises, and whether this falls within the boundaries of what is reasonably practicable to manage risks. As with any control or monitoring measure, it should be based upon a specific Legionella risk assessment and agreed by a competent person (Responsible Person, Water Safety Group etc.). This might be based on socio-economic factors, health & safety and other risks, environmental, and operational factors and considerations. Examples of these are shown in the appendix.

Pros and Cons

10. Remote monitoring is an emerging technology. For Legionella control it is critical to identify the risk, select appropriate control measures and if necessary select the right equipment and supplier for your particular remote monitoring installation. Experience in using remote temperature monitoring has highlighted a number of factors that potential users of such systems may find insightful in order to help them decide whether this approach may be appropriate, and these are summarised below.

11. Pros
Remote monitoring systems may (where sensors are fitted):

a. Provide real time (or near real time) information about system operation and availability of new, more detailed, information about system conditions.

b. Monitor remotely, so reports of issues with water temperatures by site users can easily be verified before taking further action.
c. Allow monitoring in difficult to access places. This could mean a geographically remote location or a building or part of a building where access is restricted for reasons, such as infection control, vulnerability or security. Labour savings can be made by installing sensors on return loops which would negate the need to regularly lift ceiling tiles or remove IPS panels.

d. Identify unused outlets or areas of stagnation through lack of temperature change to support removal of no/low use outlets.

e. Provide potential indication of leaks or identification of outlets left open.

f. Provide confirmation of flushing.

g. Assist in the management of scald risk.

h. Enable "...timely appropriate remedial action to poor temperature results." (para 2.53 HSG 274 part 2).

i. Provide much improved visibility of system issues which has a variety of benefits including:

i. Potentially lowering monitoring costs and allowing redeployment of human resources to other, higher quality works.

ii. Providing better informed risk assessment and scheme of control.

iii. Detecting building defects during commissioning, warranty and normal operation.

iv. Reducing potential for human error and non-completion of monitoring works.

v. Improving the design of water systems, e.g. correct sizing of cold water storage, sizing of hot water calorifiers and balancing of flow and return hot water services.

j. Lead to evidence-based actions, evidence-based proportionality and proof that actions have been effective (e.g. only flushing little used outlets based on usage data).

k. Provide more comprehensive data to allow organisations, duty holders and responsible persons, to make better informed decisions on prioritising spend on remedial works.

l. Allow buildings to be managed effectively to, in some cases, reduce energy consumption (through wasted hot water), water use and biocides.

m. Provide reliable traceability (access logs) of actions.

12. Cons
Remote monitoring systems may:

a. Result in the potential for the radio waves they produce to interfere with other site systems, e.g. in healthcare. There may also be potential for security risks at sensitive locations.

b. Be prone to degradation of signals within buildings leading to expected performance not being achieved.

c. In circumstances where cold water temperatures match ambient temperatures, have difficulties detecting flow events.

d. Be subject to alterations in the software of the sensors, which can influence their temperature readings; no calibration directly to the sensor hardware.

e. Be problematic due to difficulties in calibrating sensors.

f. Be subject to manipulation of system temperature readings by users to present a false picture of system operation.

g. Be unsuitable for some pipework materials, e.g. PVC and other thermoplastics, for temperature reading from surface temperature probes.

h. Require contingencies for mass outage, e.g. power cut, signal loss or data corruption.

i. Generate a huge amount of data that could overwhelm available resources to respond to and manage this data. This could lead to inappropriate decisions being taken about the actual risk present and the resources needed to manage an incorrectly perceived risk.

j. Be incompatible with existing management systems and compliance software, meaning that not all data can be shared.

k. Be prone to other potential system issues, such as (and based on experience) probes losing contact with the pipe and data hubs either being switched off or stolen.

l. Still require some manual interaction to validate equipment and take periodic temperature readings. The water system will still require tank inspections, shower cleaning, etc.

m. Due to lack of standards and guidance, be difficult to know where to set alarms and understand when to take action when readings indicate that temperature measurements are sub-optimal.

Questions to ask

13. It is critical that monitoring data generated is reliable and anyone looking to buy and install remote monitoring equipment should consider the following questions.

14. Is the hardware fit for purpose?

   a. How do the sensors measure temperature? E.g. is it by contact probes, probe pockets, immersion, etc.?

   b. Is this method of measurement suitable for my pipe material and size?

   c. How are the sensors installed? Is there any risk of them becoming separated from the pipe?

   d. Will the sensors and other associated equipment communicate through my building? You may need to tell the supplier what your building is constructed from and how thick walls and floors are.

   e. How often does the equipment require replacement batteries or verification? How easy is it to maintain?

   f. How can you tell if a sensor is malfunctioning?

   g. How does frequency of measurement affect the battery life?

   h. How long will sensors be supported by the supplier, and what happens when they are superseded?

15. How is the data delivered?

   a. Is there a time delay between a reading and delivery to the interface?

   b. Is data robustly backed up? Where is data stored? UK? Security considerations.

   c. What data is provided? All data or high/low/average figures?

   d. How frequently are measurements taken?

   e. Does data transfer require a cabled network connection to the sensors?

   f. How user friendly is the interface? This is subjective but important.

   g. Can the interface manipulate data to generate reports? Can it export data in usable formats such as CSV files?

   h. Can the interface generate alerts/non-conformances and how are these managed? Do these meet the requirements of the existing Legionella risk management guidance? Are they user configurable?

   i. How reliable is data transfer?

   j. Is data transfer reliant on a customer's own local network and/or internet connection?

   k. Can the system be integrated with existing water hygiene management software or building management systems?

   l. At the end of the contract who owns the data? And can it still be accessed for 5 years from the time of data collection, as required by COSHH?

16. How is the system designed and installed?

    a. Where will sensors be located and have these decisions been made by those with an understanding of the building water systems installed, the people using these systems, the Legionella risk assessment and the guidance in place?

    b. Are there enough sensors to give a useful thermal profile that informs on the Legionella risk?

    c. Will the placement of sensors be prone to damage, vandalism, unintentional switch off, etc.?

    d. Are the sensors invasive/intrusive?

    e. Do the sensors require access to an external power source to operate?

    f. Who will install the system, are they competent to do so, can you provide evidence for this?

    g. How will the system be commissioned? How will the system be calibrated?

    h. Is the supplier able to provide ongoing technical and practical support?

    i. Who is responsible for training the end user? Both initially and after system upgrades/updates?

17. Security considerations (these may be internal questions or a conversation with the supplier)

    a. Will this system's communication interfere with other systems on the premises?

    b. Is this type of equipment permitted at my site under the site security conditions?

    c. How secure is the data transfer, e.g. end-to-end encryption, 2 factor authentication for end user?

18. Communication

    a. What is the best communication method for my application? (WiFi, BLE, NBIOT, low frequency, cellular etc.)

    b. What are the ongoing communication costs?

    c. What is the network coverage in my area?

19. Environmental

    a. How much of the product is recyclable?

    b. What is the carbon footprint of the supply chain?

    c. How does the carbon footprint compare with existing manual monitoring?

20. Financial

    a. How much does the system cost over its lifespan?

    b. Lease or purchase? Operational expenditure versus capital expenditure.

    c. What are the likely ongoing costs of support?

d. What does the warranty cover?

e. What is the ongoing cost of access to the software?

This initial document is intended to help dutyholders and those involved in managing the risk of Legionella to consider whether adopting a remote monitoring approach is suitable for their organisation. Further guidance will be issued covering interpretation and management of the data to provide better understanding of water systems safety.

It should be noted that after installing any additional hardware or changing the method of control, the legionella risk assessment must be reviewed and updated.

Remote Monitoring Terminology Explained

API stands for Application Programming Interface. An API is a software intermediary that allows two applications to talk to each other. In other words, an API is the messenger that delivers your request to the provider that you're requesting it from and then delivers the response back to you.

Artificial intelligence, sometimes called machine intelligence, is intelligence demonstrated by machines, in contrast to the natural intelligence displayed by humans and other animals.

BLE - Bluetooth is a short-range wireless technology standard that is used for exchanging data between fixed and mobile devices over short distances, essentially a proximity restrained communication. **Pros:** Easy to use. Local connection used by many devices. **Cons:** Can use up a lot of battery on non-mains fed devices. Is proximity restrained.

Cellular/Mobile Networks - Cellular or mobile networks are communication networks that transmit and receive from fixed cell towers that cover large areas and can send large data. They can be expensive when only wanting to send small data. **Pros:** Connection used by many devices. Good signal coverage. Can send large data. **Cons:** Can be costly to send data. Could drain down battery on mobile devices.

Data mining is the process of discovering patterns in large data sets involving methods at the intersection of machine learning, statistics, and database systems.

IOT - The Internet of Things is the network of physical devices, vehicles, home appliances, and other items embedded with electronics, software, sensors, actuators, and connectivity which enables these things to connect, collect and exchange data.

Low Power Networks - A low-power wide-area network (LPWAN) is a wireless communications network that by using local gateways allow for long range communications. They normally use the unlicensed spectrum and can limit the amount of data you send. They are meant to be cheaper to use than conventional communications such as cellular. **Pros:** Connection used by many devices. Cheap way to send data. **Cons:** May not cover all areas requiring monitoring. Restricted by signal capabilities in large buildings.

Machine learning is a series of algorithms that builds a theoretical model based on sample data, known as training data, in order to make predictions or decisions without being explicitly programmed to do so.

Multi-factor authentication is a method of confirming a user's claimed identity in which a computer user is granted access only after successfully presenting two or more pieces of evidence to an authentication mechanism: knowledge, possession, and inherence.

NBIOT - Narrowband Internet of Things - is a low-power wide-area network normally using cellular infrastructure which has few restrictions on uploading and downloading data operating on the licensed communications spectrum. **Pros:** Connection used by many devices. Cheap way to send data. **Cons:** Can have a greater capital cost to the customer. Restricted by signal capabilities within large buildings.

Predictive analytics encompasses a variety of statistical techniques from data mining, predictive modelling, and machine learning, that analyse current and historical facts to make predictions about future or otherwise unknown events.

SAR, is a measure of the rate of RF (radiofrequency) energy absorption by the body from the source being measured – in this case, a mobile phone. SAR provides a straightforward means for measuring the RF exposure characteristics of mobile phones to ensure that they are within the safety guidelines set by the FCC.

Satellite - Using amplified telecommunications to be sent to a communications satellite that relays the messages. This can be an expensive system to use and problematic for small data retrieving devices due to power requirements. **Pros:** Connection used by many devices. Widely available. Fast upload/download. **Cons:** Can be costly. May require more infrastructure.

SDK - Software Development Kit - the term is generally used to refer to a set of resources made available by platform vendors to enable development on that particular platform.

Wi-Fi is a wireless networking technology that is restricted by distance and sometimes security protocols which allows devices such as computers and others to interface with the Internet. It allows these devices to exchange information with one another, creating a network. **Pros:** Easy to use. Connection used by many devices. Good connectivity option local to router. Cheap way to send data. **Cons:** Could be considered a security risk to current IT Infrastructure. May not cover all areas requiring monitoring. Restricted by signal local network.

References

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ACoP L8
https://www.hse.gov.uk/pubns/books/l8.htm

HSW Act
https://www.legislation.gov.uk/ukpga/1974/37/contents
https://www.hse.gov.uk/legislation/hswa.htm

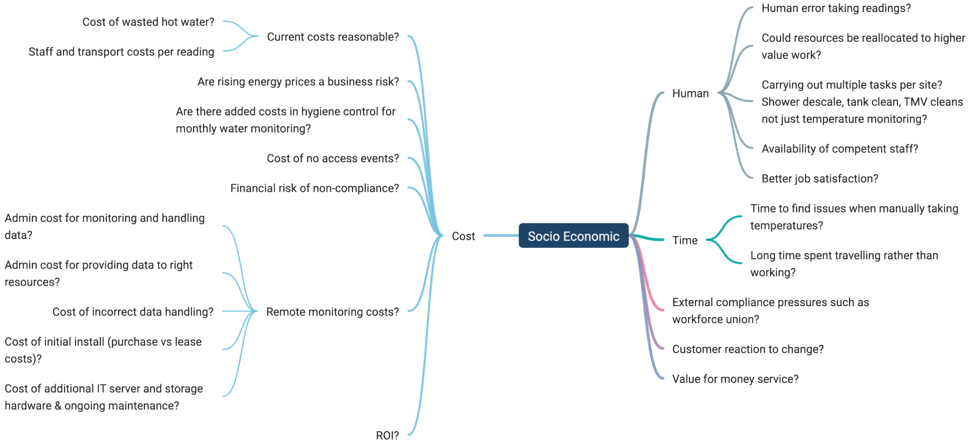
MHSWA
https://www.legislation.gov.uk/uksi/2006/438/contents/made

HSG 274
https://www.hse.gov.uk/pubns/books/hsg274.htm

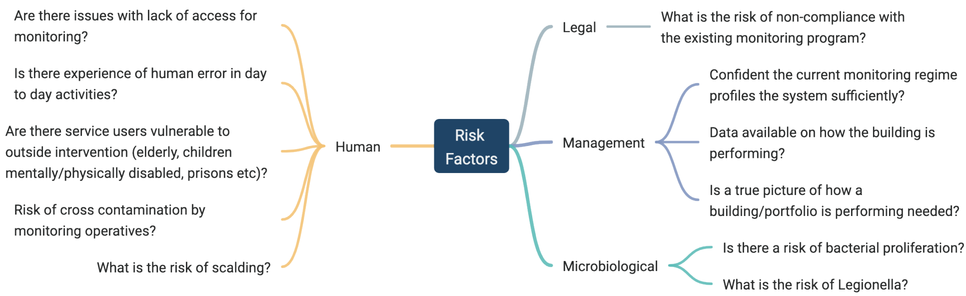
HSG alarm management
https://www.hse.gov.uk/humanfactors/topics/alarm-management.htm

Explanation of 'reasonably practicable'
https://www.hse.gov.uk/managing/theory/alarpglance.htm

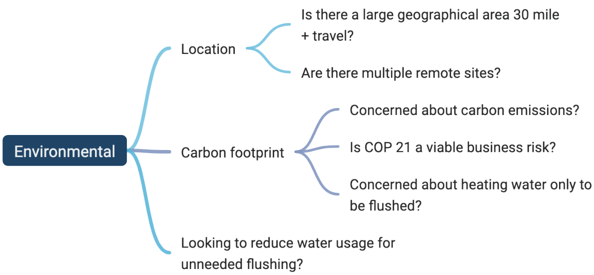
Appendix
Socio-economic factors



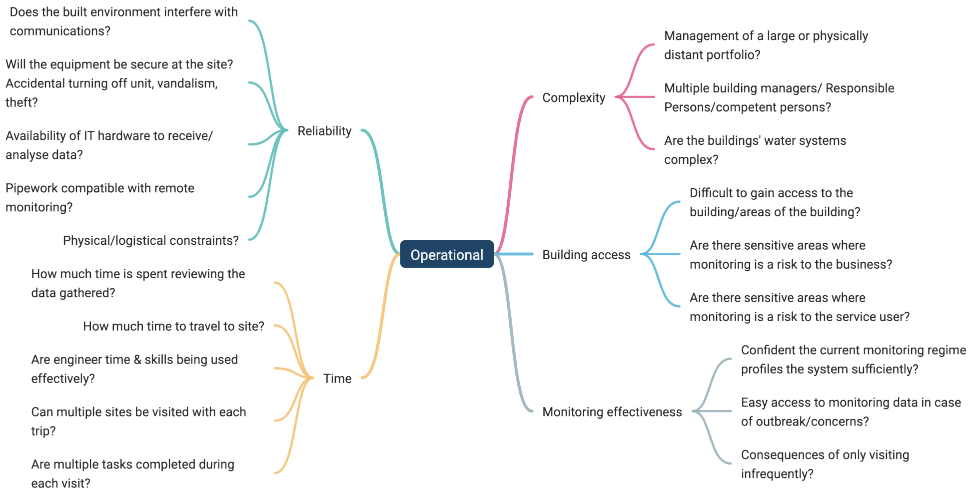
Health & safety and other risk factors



Environmental factors



Operational factors



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