



SOLVING PROBLEMS FROM LEGIONELLA CONTAMINATION IN A CZECH HOSPITAL

1 Organisations involved

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2 Description of the case

2.1 Introduction

It is well known that there is a potential for growth of pathogenic bacteria in the plumbing system of buildings. While pathogenic waterborne bacteria such as *Legionella* spp. are ubiquitous in the natural environment, their presence and colonisation in plumbing systems can be related directly to the design, operation and maintenance of the buildings' water system.

From the customer's point of view, the basic requirement for a plumbing system is its ability to be technically functional over a long period, even when the system has to be expanded to encompass or be integrated with other systems e.g. cooling systems. From this point of view, it is necessary to make certain arrangements and adjustments in the case of older buildings, while for new buildings it is better to design and monitor the system from the very beginning in order to keep costs down and ensure the efficient operation of the system. The engineers should try to estimate the water consumption, minimise 'dead legs' where water collects, install facilities for the removal of sediments and pay particular attention to the critical points in the system. Whenever a section of the system is renovated, the whole water system should be checked to ensure that the plumbing and heaters are still fit for use.

In the design of a water supply system it is necessary to concentrate on the following technical problems:

- The quality of drinking water, in order to minimise the health risk from waterborne pathogens
- The operating conditions of water heating equipment in order to obtain adequate water flow during both peak and low flow periods
- The operation of a distribution net and ancillary equipment, to ensure the appropriate water temperatures, minimise energy consumption and maximise the lifespan of the equipment
- Record keeping of the operational data, reports on any abnormalities, maintenance records, etc.
- The protection of users and maintenance technicians from potential contamination from *Legionella* bacteria.

This initiative was intended to eliminate *Legionella* in the water supply systems in the new building of the Hradec Králové University Hospital.

2.2 Aims

The aim was to incorporate in the design of the water supply system elements that will provide protection from Legionnaires' disease.

2.3 What was done, and how?

In the Hradec Králové University Hospital the main parts of the water supply system and their requirements are:

- The water heating equipment and its regulatory system: maintaining an adequate flow of hot water during peak use conditions is usually a problem. During the testing of any new facility, 10% of all distal sites in the building (taps and showers) should be opened fully for 15 minutes. If the pipes are too long, this results in low, almost stagnant flow rates even during peak use periods.
- Distribution net: control measurements (temperature, water-flow, organoleptic quality (taste, smell, etc.)) of water at specified distribution points, operational security measures for users, e.g. for the prevention of scalding. Sediment has to be removed from the main horizontal distribution headers.
- Hygienic protection of hot water produced: chemical disinfection and application of a monitoring plan. The use of thermal disinfection is not recommended because it has a detrimental effect on the water heating equipment and the distribution net, and the risk of scalding is high.

Clean systems with proper temperatures and appropriate levels of disinfectant minimise the possibility of deposition, corrosion or biofilm formation. All of these, if present to some degree, help promote *Legionella* growth. In addition, the maintenance costs of clean systems are lower.

The new building (INTERNA) of the Hradec Králové University Hospital was constructed from 2002 to 2004. Dr Ing. Zdeněk Pospíchal was the technical supervisor of the hospital from the beginning of the project to the beginning of its operation. Technical expertise in disinfection procedures was provided by QZP Ltd., Brno.

The design of the installation for the production of thermally stable hot water with a supply capacity of 13.5 m³ per hour was based on patent CZ 285 923. It included the design of the chemical treatment procedure (dosing of biocides, e.g. stabilised chlorine dioxide and non-chlorine polymer disinfectants). One of the most reliable and effective methods is the use of an active system of biocides such as copper-silver or chlorine dioxide. The system can deliver an active, testable amount of disinfectant at all distal points in the facility. Chlorine dioxide can be fed to both the cold and the hot water system. Feeding chlorine dioxide to the cold water system affords better protection and allows more contact time for killing the bacteria. Treated cold water minimises the possibility that hot water systems will be contaminated by untreated cold water systems at the distal points (taps and showers).

For the construction of the plumbing network, selected plumbing material, hydraulic balance of circulation and tangential filters in piping were used. In order to control pathogens, the hot water supply and return systems were balanced hydraulically and this was maintained and monitored electronically. The supply and return system is kept running 24 hours a day. Like the human vascular system, the hot water system requires continuous flow to all parts without exception. Low or no flow in even one part of the system results in the formation of deposits and biofilm that can lead to *Legionella* infection.

When the project was completed, tests were carried out on the hot water in the distribution net. The process operated at a lower temperature (49.5 °C instead of 56 °C), thus decreasing energy use and eliminating risks from scalding. In the INTERNA building, no *Legionella* was detected and hot water was fully secure from a hygienic point of view (see Table 1 below).

Table 1: Legionella colonisation and water temperature, University Hospital Hradec Králové, INTERNA Building; comparison 2004 (start of operation) and 2006

	16.6.2004		23.5.2006	
Place	(°C)	Legionella (CFU in 100ml)	(°C)	Legionella (CFU in 100ml)
Exchanger-PWH	59,5	0	49,5	0
Exchanger-PWH-C	54,5	0	46,8	0
Cardio 1	57,4	0	46,8	0
Cardio 2	56,9	0	47,1	0
Cardio 3	56,3	0	47	0
Cardio 4	55,0	0	46,9	0
Filter - staff	56,5	0	46,8	0
Shower - staff	58,4	0	47,1	0
Shower coronary -	-	-	45,7	0
Shower gastroent. -	-	-	46,8	0
JIP B	-	-	46,2	0
JIP A	-	-	44,9	0

The most important step in the project was the development and the implementation of a long-term plan to control waterborne pathogens. The plan included routine monitoring of critical parameters to ensure that the system performed within design specifications. The functioning of the hot and cold water system was only one part of a risk management plan to control *Legionella*. The plan also included information exchange on infections with infection control services.

2.4 What was achieved?

- *Legionella* contamination of the hot and cold water supply system in a new building at a hospital was avoided by applying a chemical treatment procedure requiring a low energy consumption.
- The lifespan of the hot water equipment and the distribution pipes was extended, and the possibility of scalding was lowered.
- The project was awarded the First Prize in Energy Globe award 2008 in the category: WATER.

2.5 Success factors

Legionella contamination was avoided by choosing optimum conditions of disinfectant concentration and water temperature.



2.6 Further information

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2.7 Transferability

The experience acquired can be applied to all buildings where the production and distribution of hot water must follow the highest quality criteria and where health risks from *Legionella* must be avoided.

2.8 Abstract

A chemical disinfection procedure for the water supply system in a new building at the Hradec Králové University Hospital was developed, based on patent CZ 285 923. The technique uses lower temperatures to achieve *Legionella* elimination and is energy-saving.

3 References, resources:

1. Information provided by Dr. Ing. Zdeněk Pospíchal
2. <http://www.legionellae.org/relatedlinks/Technical%20Perspective%20on%20Controlling%20Legionella.pdf>
3. <http://www.qzp.cz/english.php>