Evaluation of the risk of *Legionella spp.* development in sanitary installations

K. Dinne, O. Gerin, B. Bleys, K. De Cuyper

Belgian Building Research Institute

Belgium

Content

1. Introduction

Why new Legionella research?

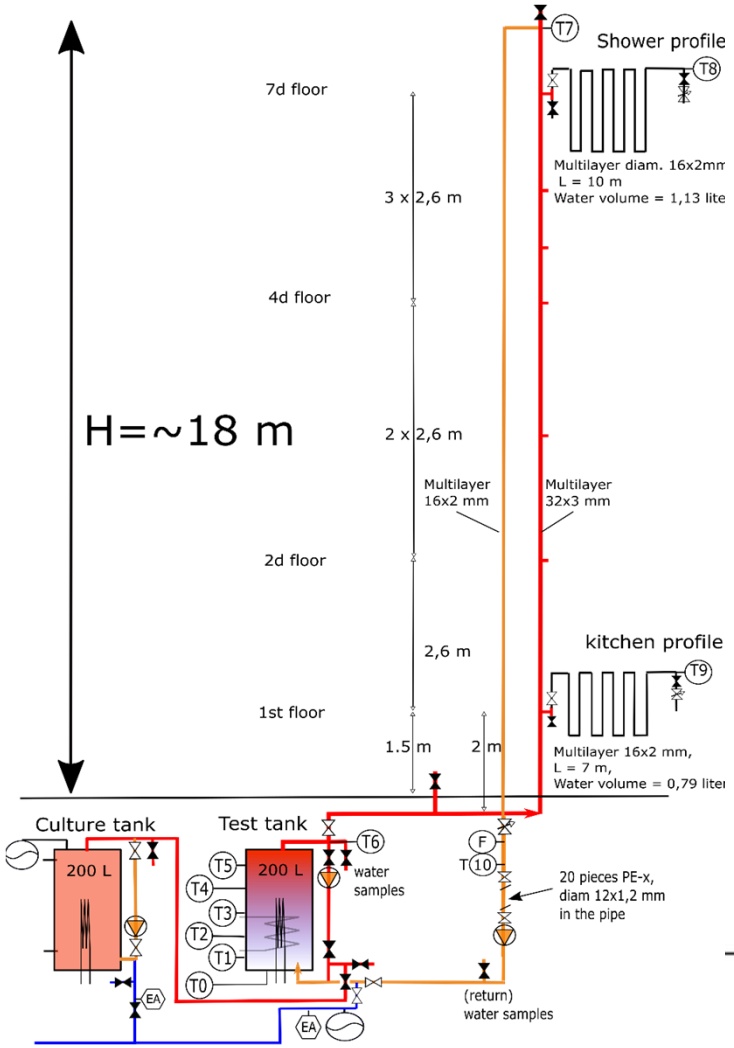
- Energy context:
  - *Reducing the energy needs* for buildings is a *European challenge* in order to meet the *2020 requirements*: all new buildings must be *near zero energy buildings*
  - As the energy-use for space heating continues to diminish, *energy-use for domestic hot water* (DHW) becomes *increasingly relevant*
  - *Efficient design* of DHW installations becomes ever more important
  - Pressure to *reduce DHW production temperatures* in certain types of installations (installations with heat pumps, low district heating, etc.)
- Hygienic context:
  - Having a *good water quality at the faucet is essential*, and certainly more important than energy related aspects
  - Risks of lower DHW production temperatures with regular thermal shocks have not been studied in detail

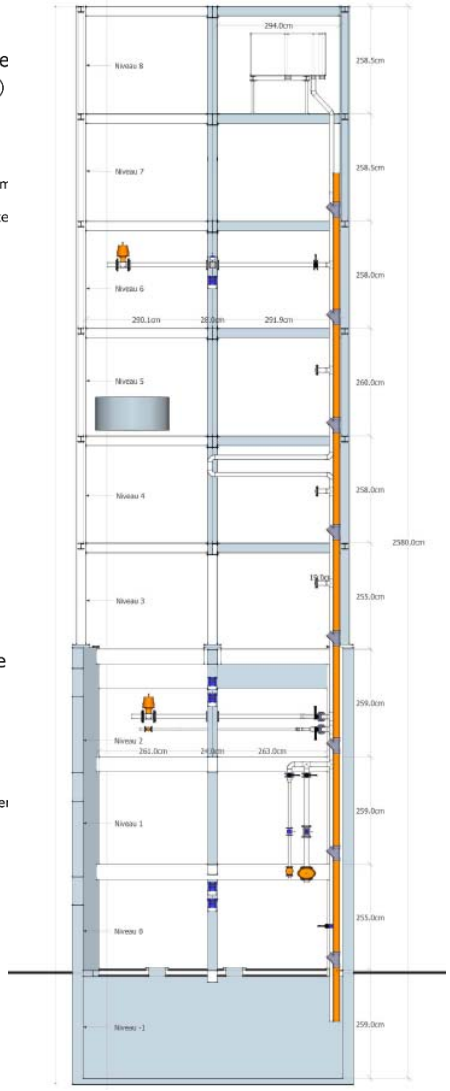
1. Introduction (2)

What are we doing at BBRI?

- Evaluation -on a full scale test facility- of the possibility to reduce the DHW production temperature without increasing risk of Legionella development
- The test facility consists of:
  - 200 l water tank
  - ~ 40m circulation loop
  - 2 draw-off pipes (bathroom and kitchen)
  - Single family tapping profile: 156 l/day
- DHW at 45°C with regular heating to 60°C
- Monitoring of Legionella concentration in water and biofilm

2. The BBRI test facility



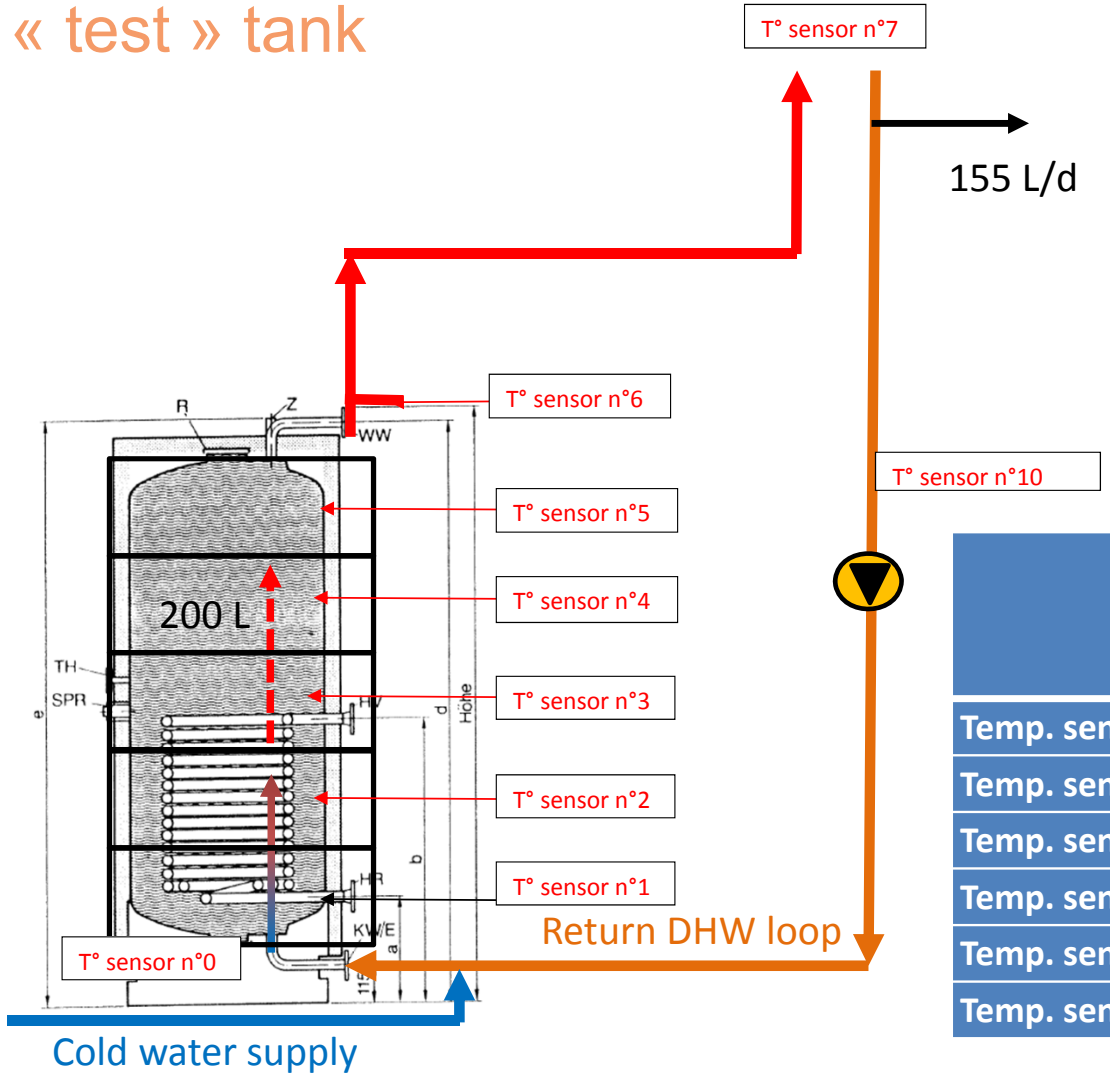


2. The BBRI test facility (2)

- Culture tank:
  - 200 l
  - Temperature: 39°C
  - Daily draw-off of 127 l
  - Stable concentration of 2.10^5 cfu/L
- "test" tank:
  - 200 l
  - Temperature: 45°C
  - Daily tapping profile
  - Heating element: vertical electrical resistance (6 kW)
  - Thermocouples on outside wall
- Circulation loop:
  - Vertical pipes: DN32 with DN16 recirculation
  - PEX-Alu-PEX with PIR insulation

2. The BBRI test facility (3)

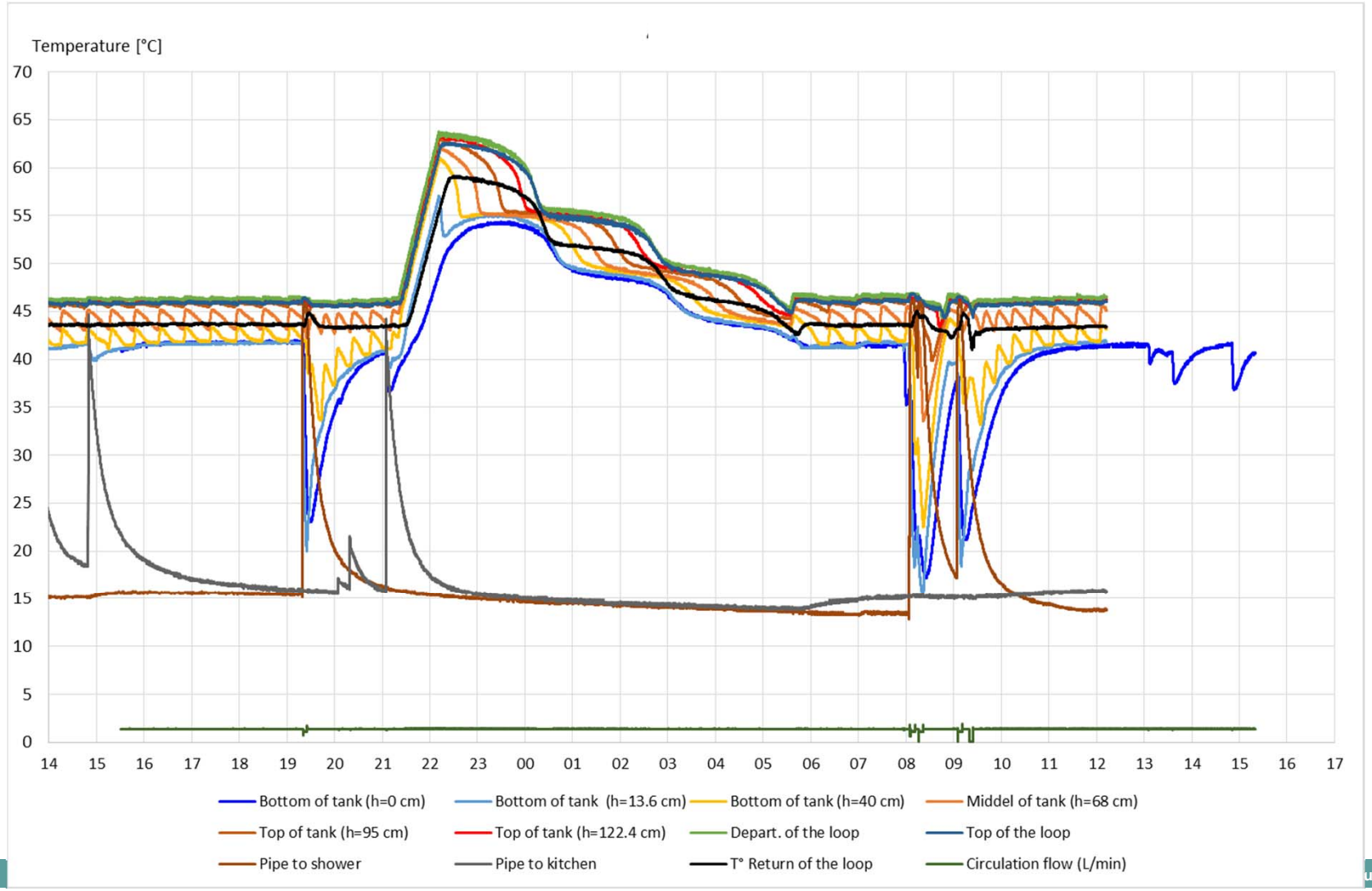
« test » tank



	Distance from bottom (cm)
Temp. sensor n°5 :	122.4
Temp. sensor n°4 :	95.2
Temp. sensor n°3 :	68
Temp. sensor n°2 :	40.8
Temp. sensor n°1 :	13.6
Temp. sensor n°0 :	0

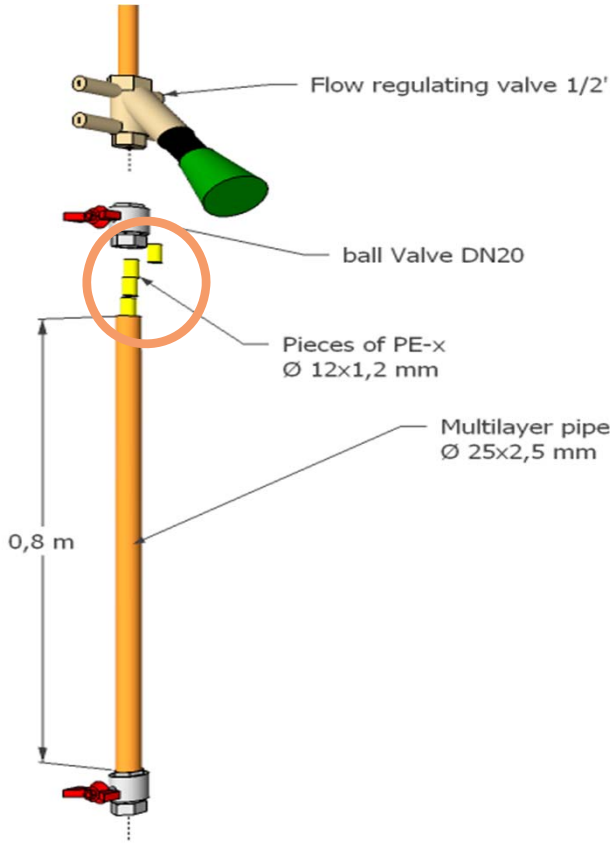
2. The BBRI test facility (4)

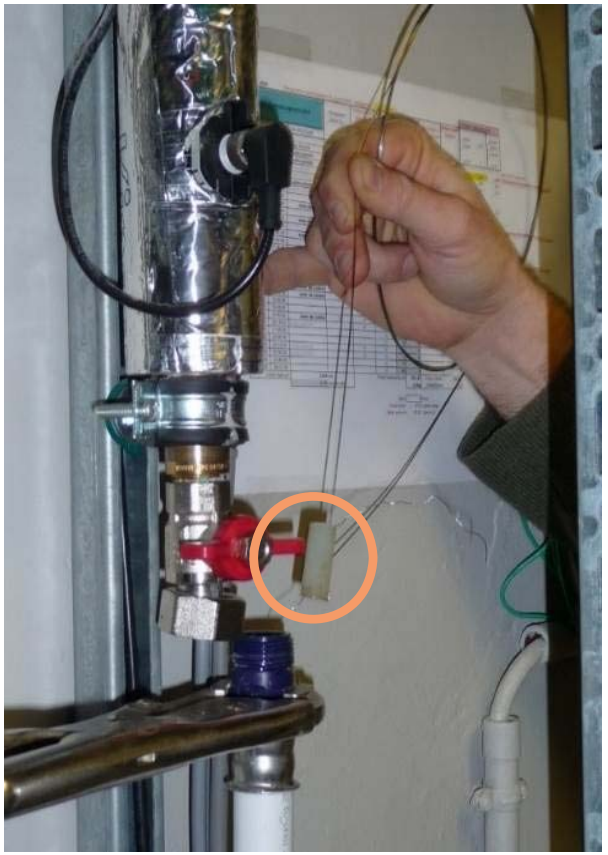
60°C/ 1h



2. The BBRI test facility (5)

Biofilm monitoring





2. The BBRI test facility (6)

Tap schedule		DHW Flow-rate	Tap duration	Tapped DHW volume
Start hour	Type of draw-off	l /min	s	liters
06:59	purge of the shower pipe	6.5	10	1.083
07:00	Shower n° 1	6.5	355	38.5
07:10	Shower n° 2	6.5	393	42.6
08:00	Shower n° 3	6.5	296	32.1
12:00	Kitchen faucet	5	6	0.50
12:30	Kitchen faucet	5	20	1.67
13:45	Kitchen faucet	5	30	2.50
18:15	Children's bath (40 L)	6.5	311	33.7
19:00	Kitchen faucet	5	6	0.50
19:15	Kitchen faucet	5	3	0.25
20:00	Kitchen faucet	5	30	2.50
	Total tapped daily DHW Volume :			**155,79 l**

2. The BBRI test facility (7)

Heat shock experiments

weeks	T production (tank)	T heating (thermal shock)	Heating duration	Frequency	Number of thermal shocks
1 and 2	45 °C	60 °C	***30 min***	1x / week	2 shocks
3 and 4	45 °C	60 °C	***1 h***	1x / week	2 shocks
5	45 °C	60 °C	30 min	1x / week with ***extra circulation on tank***	1 shock
6 and 7	45 °C	60 °C	1 h	1x / week with extra circulation on tank	2 shocks
8 and 9	45 °C	60 °C	1 h	1x / week with extra circulation on tank. + 30 minutes ***thermal disinfection of the sampling taps***	2 shocks

2. The BBRI test facility (8)

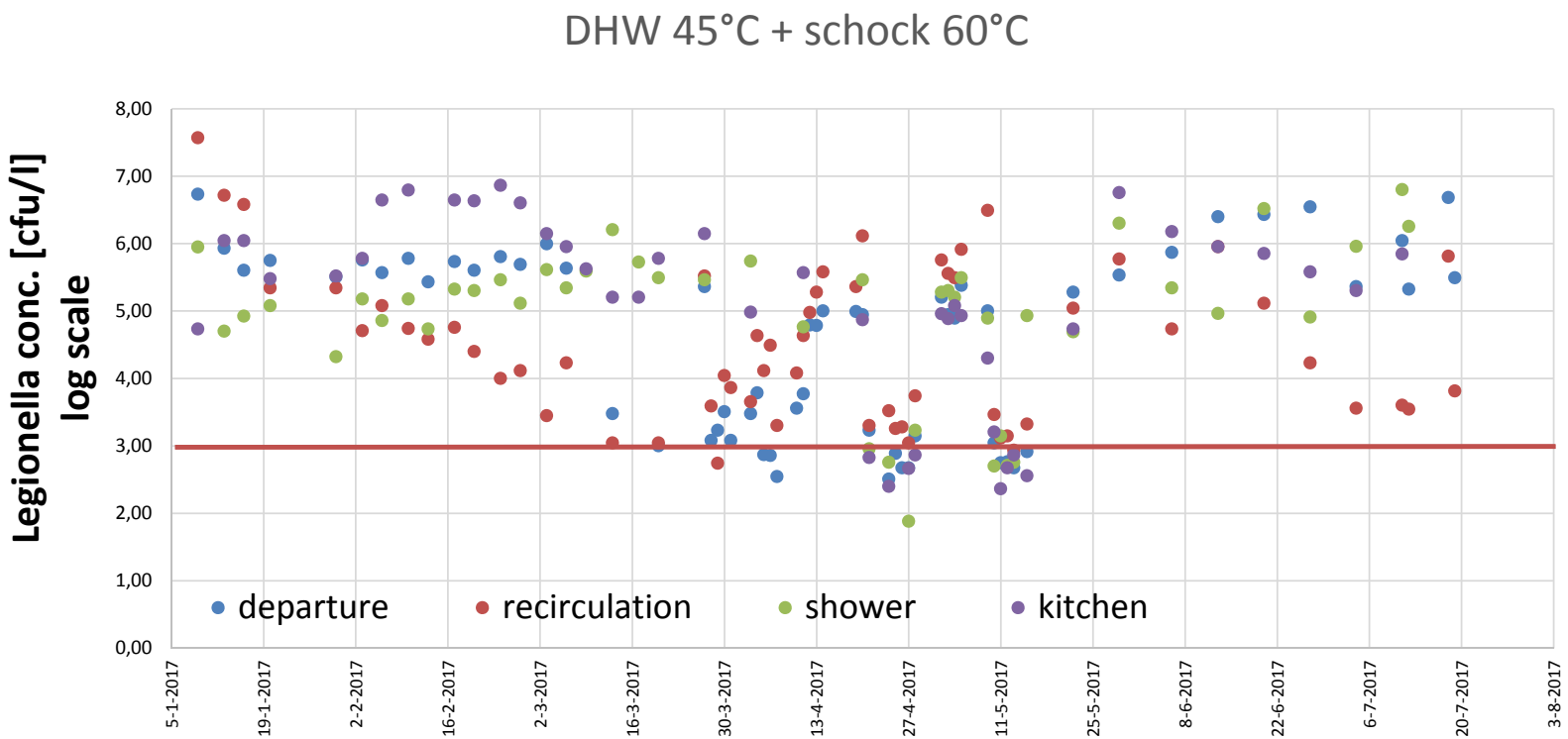
Heat shock experiments

weeks	T production (tank)	T heating (thermal shock)	Heating duration	Frequency	Number of thermal shocks
10	45 °C	60 °C	Warming up +4 x 30 min (for taps disinfection)	1x / week with extra circulation on tank. + 4 x 30 minutes thermal disinfection for each of the sampling taps ***and draw-off pipes***	1 shock
11	45 °C	60 °C	Warming up +30 min (for tank) + 4 x 30 min (for taps disinfection)	1x / week with extra circulation on tank. + 4 x 30 minutes thermal disinfection for each of the sampling taps and draw-off pipes	1 shock
14-18	45 °C	60 °C	1 h	***2x / week*** with extra circulation on tank	9 shocks
19	45 °C	60 °C	1 h	***7x /week*** with extra circulation on tank	7 shocks

3. First results

- In the test facility:

  None of the thermal shocks lead to acceptable Legionella concentrations (< 1000 cfu/l) in the DHW installation



3. First results (2)

- Heating of watersamples in laboratory taken from the test facility:
  - at ***65°C no*** Legionella ***bacteria survived***, even if the thermal schock only lasted ***5 min***.
  - At ***60°C*** for ***60 min***, Legionella concentration decreased from 100.000 cfu/l to 250 cfu/l. ***Cultivable bacteria remained.***
- Biofilm monitoring:
  - Progressive decrease (from 3.3 10^6 to 2.5 10^3 cfu/l) of the Legionella concentrations
  - After 15 days without thermal shock: return to initial concentration

4. Preliminary conclusions

- Important to standardise sampling methodology and to disinfect the sampling points
- In a contaminated installation, with ***DHW production temperature of 45°C***, a ***regular thermal shock at 60°C seems insufficient*** to stabilise the Legionella concentration below 1000 cfu/L
- As laboratory tests are promising with shocks at 65°C and 70°C, more combinations will be studied:
  - Higher thermal shock temperature, duration and frequency
  - Higher DHW production temperature (50°C, 55°C)
- Test will be continued till September 2018

Thank you
for your attention