DVGW
Regelwerk

Technical Rule

Code of Practice W 551 | April 2004

Drinking water heating and drinking water piping systems; technical measures to reduce *Legionella* growth; design, construction, operation and rehabilitation of drinking water installations

ISSN 0176-3504
Pricegroup: 5

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Preamble

Pathogens can be transmitted along different paths. One of the transmission paths is water. The largest health risks by waterborne pathogens emanate from pathogens that are transmitted by faecal-oral route. Cholera and typhus are two typical pathogens transmitted by faecal-oral route, which in the past have time and again led to heavy outbreaks of waterborne diseases on account of drinking water.

However, there is yet another group of pathogens that can be transmitted with the water. These pathogens typically multiply in water and can thus lead to a health risk. This group also includes *Legionellae*. As a rule, they cause symptoms similar to pneumonia. *Legionella* is an ubiquitous organism, however, in a natural environment it occurs in such marginal quantities that it does not entail a health risk for humans. However, in heated water at temperatures between 30 ºC and 45 ºC, *Legionellae* can multiply strongly and thus cause a health risk if they are inhaled in small respirable droplets (aerosol) with the air. A health risk may arise in connection with the drinking water if the *Legionellae* grow in the drinking water installation's hot water system and are then for instance inhaled during showering. The *Legionella* problem is aggravated by the fact that the *Legionellae* are characterised by massively multiplying intracellularly inside protozoa such as amoeba.

This Code of Practice describes the measures that are necessary to prevent multiplication of the *Legionellae* in drinking water installations hot water systems on a massive scale or to eliminate them from such systems where they have already multiplied. This Code of Practice summarises the requirements which have already been stipulated beforehand in the two Codes of Practice W 551 and W 552 of 1993 or 1996. The requirements have been adapted to the latest knowledge in the field of combating *Legionellae* in hot water systems.

Bonn, April 2004

DVGW German Technical and Scientific Association for Gas and Water

1 Introduction

Legionellae are rod shaped bacteria that are ubiquitous organisms in aquatic environments. They typically lead to pneumonia (legionella pneumonia). Apart from *Legionella pneumophila* - the most important type from an epidemiological point of view - there are more than 40 other species.

At a meeting of the “US American Legion” in Philadelphia in 1976, 220 of the more than 4000 participants fell ill, 30 of which died. For this reason, the disease was named “legionnaires’ disease”,

Apart from *Legionella* pneumonia there is another less serious course of a *Legionella* infection, the Pontiac fever.

Persons with pre-existing health problems, weakened immune system, chronic bronchitis, emphysema, etc., but also smokers, come down with the disease more frequently.

The risk of infection is directly related to the temperature of the water from the drinking water installation. *Legionellae* growth increases in the temperature range between 30ºC and 45ºC. Infection primarily takes place by inhalation of contaminated respirable aerosol, which for instance arises during showering.

This Code of Practice describes the required technical measures and other precautions to avoid a health risk by *Legionellae* in water from the drinking water installation.

The rules contained in this Code of Practice are based on the current state of knowledge with regard to technical measures to reduce the growth of *Legionellae*.

2 Scope

This Code of Practice applies to

- the design and construction
- the operation
- the upkeep (inspection, maintenance and repair)
- the hygienic-microbiological monitoring, and
- the rehabilitation

of drinking water installations in public and privately used buildings (residential, office and administration buildings, work and sport facilities, hotels and hospitals).

In hospital areas with patients, who due to an immune deficiency are particularly at risk, additional measures are possible required. These are not subject of this Code of Practice.

In principle, it is possible to comply with the objective aimed at by this Code of Practice using other technical measures and procedures. In these cases, the existence of unobjectionable conditions has to be demonstrated by microbiological examinations.

In this connection, reference has to be made to the duty of disclosure to the responsible local health authority. According to §13 subparagraph 1, Drinking Water Ordinance 2001 this duty exists if water-carrying parts of a domestic installation from which water is dispensed to the public (hospitals, old age homes, nursing homes, hotels, restaurants, schools, nursery schools, etc.) are changed from a constructional or operational point of view such that this may have an effect on the quality of the water intended for human consumption.

3 Normative references

The following normative documents contain specifications, which by referencing in this text form an integral part of the DVGW system of rules on hand. In case of dated references, later amendments or revisions of this publication shall not apply. Users of that part of the DVGW system of rules are however requested to check the possibility of applying the respectively latest editions of the normative documents listed below. For undated references, the last edition of the normative document referred to shall apply. Listed DIN standards may be part of the DVGW system of rules.

Energy Saving Ordinance; Ordinance on energy saving heat insulation and energy saving systems engineering in buildings (Energy Saving Ordinance – EnEV)

TrinkwV, *Ordinance for the amendment of the Drinking Water Ordinance (Clause 1 Ordinance on the quality of water for human consumption (Drinking Water Ordinance – TrinkwV 2001); Clause 2 Amendment of other legal provisions)*

DIN 1988, *Technical rules for drinking water supply systems (TRWI)*

DIN 4708, *Central heat-water installations in dwelling houses*

DIN 4753, *Water heaters and water heating installations for drinking water and service water*

DIN EN 1717*, Protection against pollution of potable water installations and general requirements of devices to prevent pollution by backflow - Technical rule of the DVGW; Pathogenan version EN 1717:2000*

DVGW Code of Practice W 291, *Cleaning and disinfection of water distribution systems*

DVGW Code of Practice W 293, *UV systems for the disinfection of drinking water*

DVGW Code of Practice W 294, *UV disinfection systems for the drinking water supply*

DVGW Code of Practice W 553, *Dimensioning of circulation systems in central drinking water heating systems*

DVGW VP 670, *Requirements and testing for drinking water heating systems*

VDI 6023, *Hygiene for drinking water supply systems - Requirements for planning, design, operation, and maintanance*

4 Terms

Systems

Drinking water installation system (reservoir and all pipelines)

Small installations

Small installations are any installations with reservoir drinking water heaters or central continuous flow drinking water heaters in:

- Single family homes and semidetached houses – independent of drinking water heater content and pipeline content
- Installations with drinking water heaters with a content ≤ 400 l and a content ≤ 3 l in each pipeline between drinking water heater outlet and draw-off point. A possible circulation pipeline is thereby not taken into consideration.

Large installations

Large installations are any installations with reservoir drinking water heaters or central continuous flow drinking water heaters, for instance in:

- residential buildings
- hotels
- old age homes
- hospitals
- spas
- sport and industrial facilities
- installations with drinking water heaters with a content > 400 l and a content > 3 l in each pipeline between drinking water heater outlet and draw-off point.
- camping sites
- swimming pools

Documentation

As-executed drawings in the case of new buildings, taking of an inventory in case of rehabilitation

Pre-heating stages

Further heaters connected upstream of the drinking water heater, for instance from heat recovery plants, solar plants

Contaminated systems

Systems with *Legionellae* ≥ 100 cfu/100 ml (cfu = colony forming units)

Orientation examination

Minimum scope of examination to determine a possible contamination of the system

More detailed examination

Examination to determine a system's degree of contamination

Follow-up examination

Examination to monitor the success of rehabilitation

Through mixer taps and regulating valves

Valve for central mixing of cold and hot water

5 Planning and construction

5.1 General requirements

DIN 1988, DVGW Code of Practice W 553 and VDI 6023 shall apply to drinking water installations.

DIN 4753 and DVGW VP 670 shall apply to drinking water heaters.

Drinking water heating systems have to be designed commensurate with state-of-the art technology as small as possible but as large as necessary according to the demand for heated drinking water. DIN 4708 shall apply to residential buildings.

The "3 litre water volume" for pipeline systems mentioned in the following sections is to be understood as upper limit; smaller water volumes are to be striven for.

5.2 Requirements on drinking water heaters

5.2.1 Peripheral continuous flow drinking water heaters

Peripheral continuous flow drinking water heaters can be used without any further measures being required if the pipe volume downstream of the continuous flow drinking water heater does not exceed 3 litres.

5.2.2 Reservoir drinking water heaters, central continuous flow drinking water heaters, combined systems and reservoir-charging systems

Every reservoir drinking water heater must be equipped with sufficiently large cleaning and maintenance apertures, for instance in the form of a hand hole (see DIN 4753-1).

During normal operation, it must be possible to maintain a temperature of ≥ 60°C at the drinking water heater's hot water outlet. This also applies to central continuous flow drinking water heaters with a water volume > 3 litres.

The drinking water heater's cold water inlet has to be designed such that a large mixing zone is avoided during draw-off.

Reservoir drinking water heaters with DVGW mark of conformity according to DVGW VP 670 for instance meet the specified requirements. In the case of reservoir drinking water heaters with a content > 400 l it has to be guaranteed by design and other measures (e.g. circulation, in the case of multiple reservoirs simultaneous charging of the individual reservoirs) that the water is evenly heated at every point.

For hygienic reasons, it may be of advantage to connect the reservoirs in series.

5.2.3 Pre-heating stages

Drinking water heating systems have to be designed such that the entire water content of the pre-heating stages can be heated to ≥ 60°C once a day.

Drinking water heaters with integrated pre-heating stage (bivalent reservoirs) have to be designed such that the entire content of the reservoir can be heated to ≥ 60°C once a day.

5.2.4 Long-distance heat supply

The flow temperature for drinking water heating has to be selected such that a temperature of 60°C can be guaranteed at the hot water outlet of the drinking water heater.

In the case of indirect connection, the temperature difference of the heat transmitter has to be taken into account.

For a long-distance heat supply, the return temperature limit has to be selected such that a stable storage temperature with the minimum temperatures specified in section 5.2.2 can be guaranteed even during post-heating operation with drinking water heating system circulation losses.

5.3 Requirements on materials

For material selection, the requirements of DIN 50930-6 have to be complied with. Any DVGW-tested material is permitted. Galvanised ferrous materials are not to be used in the hot water zone. Reference is made to the hygienic requirements of DIN 4753 with regard to drinking water heaters.

5.4 Requirements on pipeline systems

Pipeline systems

5.4.1 Pipelines for cold drinking water

Pipelines for cold drinking water have to be protected against heating in accordance with DIN 1988-2, section 10.2.2.

5.4.2 Pipelines for heated drinking water

Pipelines for heated drinking water have to be protected in accordance with DIN 1988, section 10.2.3. to limit heat loss.

5.4.3 Circulation systems

Circulation systems have to be installed in small installations with pipeline contents > 3 l between drinking water heater outlet and draw-off point as well as in large installations.

Circulation pipelines and pumps have to be dimensioned such that the hot water temperature in the circulating hot water system does not drop more than 5 K below that of the reservoir outlet temperature.

Storey and/or individual pipelines with a water volume ≤ 3 litre can be built without circulation pipelines.

Circulation pipelines have to be run up to directly in front of through mixer taps.

Gravity circulation is not suitable from a hygienic point of view.

5.4.4 Self-regulating trace heatings

Alternatively or supplementary to the circulation pipeline, trace heating can be installed. The water temperature in the system may not drop more than 5 K below the hot water discharge temperature.

Storey and/or individual pipelines with a water volume ≤ 3 litre can be built without trace heating.

5.5 Fittings

DIN 1988-2, section 4 and DIN EN 1717 shall apply for valves.

5.5.1 Draw-off fittings

Only draw-off fittings with individual locking device and, where required, with scalding safeguard are to be used.

5.5.2 Requirements on through mixer taps and downstream pipeline systems

The water volume between through mixer taps and the farthest draw-off point has to be limited to ≤ 3 litres.

5.6 Domestic water meters

No circulation pipelines can be installed downstream of domestic water meters. The water volume in the storey and individual pipelines has to be limited to ≤ 3 litres. If that is not possible, the domestic water meters have to be arranged accordingly (e.g. at the draw-off points) or self-regulating trace heatings have to be used.

5.7 Documentation

Documentation of the system in the form of as-built drawings is required for maintenance, alteration and rehabilitation measures and inspections. The scope of the documentation should be adapted to the individual case and include fluidic, thermal as well as hygienic-microbiological aspects.

The documentation has to incorporate the as-built installation drawings, the installation description, the system specifications and the maintenance and operating instructions.

If these documents are not available for possible rehabilitation measures, an on-site survey has to be carried out. Installation drawings of the entire domestic drinking water installation have to be compiled as far as necessary in conjunction with the building drawings. These should at least comprise the details listed below:

- Water heating and storage system
- Pipeline course, nominal widths and materials, valves, insulating materials and their thickness
- Connection of equipment and fixtures as well as control devices
- System specifications of for instance drinking water heating installations and treatment installations

Temperatures of cold, hot and circulation water have to be measured in the individual sections (system-specific) and at the draw-off fittings and documented.

If not yet available, water meters are to be installed in the cold water feed pipe to the drinking water heater in order to monitor hot water consumption. In extensive systems it may be necessary to determine the consumption for individual areas or buildings. Water consumption has to be monitored and recorded.

Pieces of monitoring pipe have to be dismantled and assessed from a technical point of view.

An overall assessment of necessary rehabilitation measures can only be carried out once a documentation of the domestic drinking water installation with the above mentioned system specifications is on hand.

6 Operation

6.1 Large systems

The water in large systems always has to keep a temperature of ≥ 60°C at the hot water outlet of the drinking water heater. The entire drinking water content of preheating stages has to be heated to ≥ 60° at least once a day.

For operational reasons, deviations from the required temperature of 60°C have to be anticipated within the control circuit. Short-term lowering of the temperature at the drinking water heater outlet in the space of minutes is tolerable (see for instance DIN 4708). However, it is not acceptable for the temperature to systematically fall short of 60°C.

6.2 Small systems

For small systems it is recommended to set the controller temperature at the drinking water heater to 60°C. Operating temperatures below 50°C should however be avoided at all events. However, the client or operator should be informed about the potential health risk (*Legionella* growth) within the scope of commissioning and briefing.

6.3 Systems with preheating stages

In the case of systems with external preheating stages, the reservoir content of which including preheating stages is ≥ 400 l, the entire reservoir content of the preheating stage is to be heated to ≥ 60°C once a day.

In the case of drinking water heaters with integrated pre-heating stages (bivalent reservoirs) where the overall reservoir content is ≥ 400 l, the entire content of the reservoir is to be heated to ≥ 60°C once a day.

6.4 Circulation systems

Circulation systems and self-regulating trace heatings have to be operated such that the water temperature in the system does not drop more than 5 K below the drinking water heater's hot water discharge temperature.

If hygienic conditions are unobjectionable, circulation systems may be operated at lowered temperatures for max. 8 hours in 24 hours for energy saving reasons, for instance by switching off the circulation pump.

7 Maintenance and inspection

According to DIN 1988-8, documentation regarding operation and system handling has to be handed over to the client upon commissioning unrequestedly.

After rehabilitation of a system, documentation and rehabilitation records have to be handed over to the operator.

The contractor has to compile details regarding the intervals at which microbiological follow-up examinations have to be carried out (according to section 8.3) for the operator. Test results have to be recorded.

According to DIN 1988-8, drinking water heating systems and drinking water pipeline systems have to be regularly maintained and examined. Taking out a maintenance contract should be recommended.

8 Rehabilitation

On the basis of the documentation, measures have to be specified which lead to a reduction of the *Legionella* contamination. Rehabilitation measures that were carried out have to be recorded. The objective of rehabilitation has been achieved if less than 100 CFU in 100 ml can be demonstrated at the draw-off points.

The rehabilitation measures mentioned below can only provide guidance. Other rehabilitation measures that are not mentioned can also be used. The rehabilitation success has to be demonstrated by microbiological examinations. Depending on the system configuration, it may be necessary to carry out several rehabilitation measures jointly or subsequently. Parts of the system where sedimentation may have taken place (e.g. drinking water heaters, manifolds) have to be cleaned before carrying out the rehabilitation measures listed below.

8.1 Operational measures

Operational measures refer to setting, control and regulating operations on system components and equipment with the objective of system optimisation.

As far as possible, the hot water system should be operated like a new installation (see section 6).

8.2 Procedural measures (disinfection)

The procedural measures described below should primarily be understood as immediate measures. A lasting rehabilitation success can often only be expected in combination with constructional measures.

Prior to applying procedural measures it has to be ensured that all parts of the system are suited to carrying out the measure (temperature or chemical resistance).

After thermal or chemical disinfection, it is for instance possible to use permanent UV irradiation to reduce the amount of *Legionellae* or to extend necessary disinfection intervals.

8.2.1 Thermal disinfection

Thermal disinfection is to include the entire system including all draw-off fittings. At a temperature of ≥ 70°C, *Legionellae* are eliminated within a short space of time.

Every draw-off fitting has to be charged with at least 70°C with open outlet for at least 3 minutes. Hence, the water in the drinking water heater has to be heated to a temperature exceeding 70°C. It is imperative that temperature and duration are adhered to. The discharge temperature has to be checked at every draw-off point.

To ensure that the entire system (hot water and circulation pipeline) of circulation systems is covered by this measure, all draw-off points have to be closed during the drinking water heater’s warm-up phase.

The circulation pump must be operated permanently. This operating state is maintained until a temperature of 70°C is achieved in circulation. Only then are the draw-off points thermally disinfected one after the other with open outlet.

Depending on the size of the installation and on the pipe routing, thermal disinfection has to be carried out section by section. To rule out recontamination of the system during this process, the individual sections have to be subjected to thermal disinfection immediately in succession. It may be necessary to interrupt thermal disinfection until the drinking water heaters have heated up again.

A scalding safeguard has to be provided for during thermal disinfection. After completion of thermal disinfection, the installation has to be returned to its intended use.

8.2.2 Chemical disinfection

In case chemical disinfectants are continuously added, this has to be done in line with the valid Drinking Water Ordinance. According to the current state of knowledge, *Legionellae* are not adequately eliminated with this method. Continuous disinfection with chemicals is therefore not expedient. A discontinuous addition of disinfecting chemicals in high concentrations (e.g. chlorine bleach liquor, minimum 10 mg/l free chlorine at the draw-off point) is therefore necessary. The disinfection measure has to be carried out in accordance with DVGW Code of Practice W 291.

8.2.2.1 Pipeline systems

The disinfection chemical has to reach all individual feed lines. This may be achieved by opening every draw-off point in succession. Deviating from DVGW Code of Practice W291, a dwell time of one to two hours is as a rule sufficient. The disinfectant has to be demonstrated in sufficient concentration at the draw-off point.

During the disinfection measure it has to be guaranteed by suitable precautions that no water is removed as drinking water from the treated pipeline system. If chemical disinfection is carried out section by section, treated pipeline sections have to be separated from the rest of the system.

8.2.2.2 Drinking water heaters and preheating stages

In the case of drinking water heaters and preheating stages, surface disinfection in accordance with DVGW Code of Practice W 291 has to be carried out.

8.2.3 UV Irradiation

Given adequate UV irradiation, *Legionellae* transported with the water can be reliably eliminated. The DVGW Codes of Practice W 293 and W 294 have to be adhered to, taking into account the temperature in the system.

Multiplication of the organisms on colonised surfaces in the system cannot be prevented by UV irradiation. It can thus not be guaranteed for the individual case that impeccable water is provided at peripheral draw-off points. Depending on the level of contamination, the system has to be additionally flushed and thermally or chemically disinfected at regular intervals to guarantee an impeccable water quality.

The UV systems have to be designed for the intended operating temperature and flow rate and have to be operated permanently. In extensive systems, several UV systems may possibly be required. UV systems' place of installation depends on the local conditions.

UV irradiation causes the conversion of nitrate to nitrite. The generated quantity depends on the irradiation dose, on the wave length and on the nitrate concentration in the drinking water. It has to be ruled out that the Drinking Water Ordinance limit for nitrite is exceeded (see also W 293).

8.3 Constructional measures

Constructional measures are interventions with the entire system or individual parts of the system (drinking water heater, pipelines, draw-off fittings).

The “3 litre water volume” for pipeline systems mentioned in the following sections is to be understood as upper limit. At any rate, it is more beneficial to strive for smaller water volumes.

8.3.1 Drinking water heaters and preheating stages

The reservoir size is dimensioned in accordance with the determined water consumption – for instance according to DIN 4708. Reservoirs that are not required have to be shut down and the associated service pipes separated at the branches. The daily heating of preheating stages has to be set up and guaranteed. Drinking water heaters have to be cleaned accordingly.

If necessary, the drinking water heater has to be converted by means of additional circulation of the reservoir content or installation of an external heat exchanger with charge pump to ensure that the entire reservoir content can be heated.

8.3.2 Pipeline systems

While taking into consideration flow rate, separate heating and heat insulation with insulation layer thickness at least in accordance with the Energy Saving Ordinance, every constructional measure on parts of the pipeline system or on the system as a whole has to at least achieve that the temperature in the entire system does not drop below 55°C.

Pipelines that are not required have to be separated immediately at the draw-off. It has to be checked whether hot water feed lines for rarely used draw-off points can be separated and supplied by means of peripheral drinking water heaters.

Isolating valves in drain pipes have to be installed immediately at the main pipe. Service pipes to aerators and aspirators with collective locking device should be separated.

Valves with individual locking device have to be installed.

In order to achieve the required temperature in pipeline systems with circulation, regulating valves are as a rule required for hydraulic adjustment.

8.3.3 Fittings

8.3.3.1 Draw-off fittings

Only draw-off fittings with individual locking device and scalding safeguard are to be used.

8.3.3.2 Through mixer taps and regulating valves

The water volume between through mixer taps or regulating valves and the farthest draw-off point has to be limited to 3 l by means of constructional measures. At the same time, it must be ensured that through the constructional measure the temperature specifications according to section 5.2.2 are complied with at the hot water connection of the through mixer tap and regulating valve, either by an as short as possible connection of the hot water connection to the upstream hot water circulation pipeline or by installation of a trace heating.

If it is possible to carry out all constructional measures for rehabilitation, but only the water volume between through mixer tap and regulating valve and draw-off point cannot be limited to 3 l, the pipeline network downstream of through mixer tap and regulating valve has to be treated with a procedural measure in accordance with section 8.2 to prevent an adverse growth of *Legionellae* in this section of the pipeline.

Impeccable hygiene conditions have to be demonstrated downstream of the through mixer tap and regulating valve.

9 Hygienic-microbiological examinations and assessment

The examination is to provide information about a possible *Legionellae* contamination of the system and its extent so as to be able to carry out an assessment and to take suitable defence measures if necessary.

In principle, the Drinking Water Ordinance specifications (§§ 4, 14(1) and 19(7) in conjunction with Appendix 4) have to be observed, whereby since 2003, *Legionella* examinations in domestic installations dispensing water to the public (in particular in schools, nursery schools, hospitals, restaurants, and other social facilities) are mandatory once a year.

The microbiological examination to detect *Legionellae* has to be performed in accordance with accepted methods (Federal Health Gazette 11/2000). The names of institutes that can be charged with the examination can be obtained from the responsible local health authority.

A differentiation of examinations required for system assessment into orientation examinations, more detailed examinations and follow-up examinations is made.

9.1 Orientation examination

To determine a possible *Legionellae* contamination of the system, it is first of all necessary to carry out an orientation examination. This can optionally be done using a restricted sampling pattern or according to the sampling pattern of a more detailed examination.

The orientation examination with restricted sampling pattern is an inexpensive method for systems that are free of *Legionellae*. In the case of contaminated systems however, it is not possible to initiate concrete rehabilitation measures due to the restricted scope of sampling. Assessment of examination results is carried out according to table 1 a.

The number of samples required for the orientation examination has to be selected such that every rising pipe is covered. In addition, a sample has to be taken at the drinking water heater outlet (hot water pipeline) and at the inlet to the drinking water heater (circulation pipeline) (see figure 1).

A more detailed examination's sampling scope within the framework of an orientation examination is more cost-intensive, but has the effect that rehabilitation measures can be tackled without any further delays. Assessment of the examination result is carried out in accordance with table 1b. For quantity and location of required sampling points see "More detailed examinations".

The assessment of findings has to be specified in accordance with the most unfavourable finding and the resulting measures as well as their temporal priority result from table 1a. Exceptions of this rule have to be coordinated with the responsible local health authority.

9.2 More detailed examination

The more detailed examination is to provide information about the extent of a system's contamination with *Legionellae* and facilitate initiation of systematic rehabilitation measures.

The number of samples required for the more detailed examination depends on the system's size, extent and branching. Apart from the sampling points at every rising pipe in accordance with the orientation examination it is advisable to take additional samples in individual storey pipelines (which offer evidence of possible contamination) (see figure 1).

In addition, samples have to be taken from parts of pipelines that carry stagnating water (e.g. aerating and venting pipelines with collective locking devices, drain pipes, rarely used draw-off points, membrane expansion vessels).

If there is evidence of heating of the cold water pipeline, samples also have to be taken at cold water draw-off points.

The assessment of findings and the resulting measures arise from table 1b, measures having to be specified according to the most unfavourable finding.

The assessment plan for the more detailed examination (table 1b) also has to be applied to samples taken after rehabilitation.

9.3 Follow-up examination

If a *Legionellae* concentration < 100 CFU/100 ml (CFU = colony forming units) is detected during an orientation examination, follow-up examinations in time cycles according to table 1 a, last line, in the form of repeated orientation examinations are required to monitor long-term conditions.

To check the success of rehabilitation in the case of rehabilitated systems, two follow-up examinations using the characteristics of a more detailed examination have to be carried out at 3-monthly intervals (table 1b). Subsequently, follow-up examinations in the form of repeated orientation examinations are required (table 1a).

If monitored systems with a *Legionellae* concentration < 100 CFU/100 ml are converted or upgraded, a follow-up examination with the form and scope of an orientation examination is already required after six months.

9.4 Sampling

Samples have to be taken in accordance with the respectively valid version of the Federal Environmental Agency's "Proof of *Legionellae* in drinking water and bathing water reservoirs" taking into consideration the Drinking Water Ordinance.

Immediately prior to sampling, the water temperature has to be measured. The measurement result has to be documented.

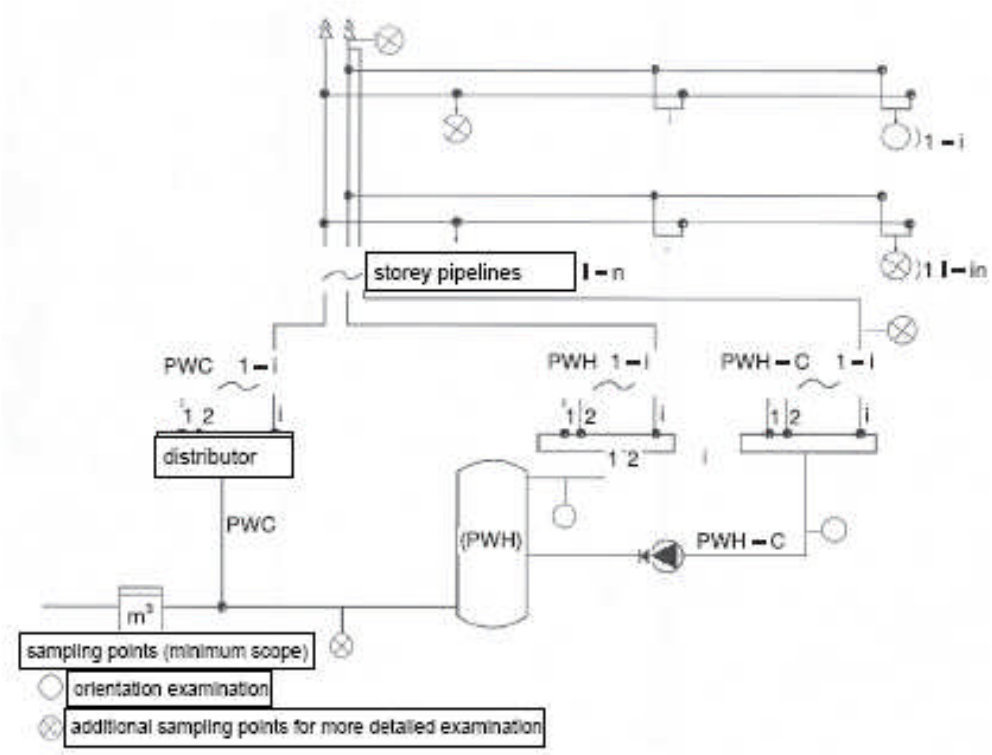

Figure 1 – Schematic diagram of a system with sampling points

9.5 Assessment of *Legionella* findings

The assessment of findings has to be specified in accordance with the most unfavourable finding and the resulting measures as well as their temporal priority result from table 1a. Deviations from this rule have to be coordinated with the responsible local health authority.

If an extremely high contamination is detected during a first examination, disinfection has to be carried out without delay.

If constantly high contaminations are detected even after repeated disinfection at short intervals, it is not to be expected that further disinfection will achieve an improvement of the situation. An extensive system rehabilitation by means of operational or constructional measures (see section 8.3) is then inevitable.

Table 1a – Assessment of findings after an orientation examination *)

Legionellae (cfu/100 ml) [1)]	Assessment	Measure	More detailed examination [3)]	Follow-up examination
> 10000	Extremely high contamination	Directly necessary to ward off danger (disinfection and restriction of use, e.g. ban on showering) Rehabilitation necessary	Immediately	1 week after disinfection or rehabilitation
> 1000	High contamination	Rehabilitation requirement depends on result of more detailed examination	Promptly	-
≥ 100	Average contamination	None	Within 4 weeks	-
< 100	No / slight contamination	None	None	After 1 year (after 3 years) [2)]

[1)] Cfu colony forming unit

[2)] If less than 100 L*egionellae* in 100 ml are demonstrated during follow-up examinations at 12-monthly intervals, the examination interval may be extended to max. 3 years.

[3)] If the orientation examination is immediately carried out with a sampling scope that corresponds to that of a more detailed examination, the measures specified in table 1 b apply immediately.

*) Examinations and assessments have to be performed in accordance with the Federal Environmental Agency's respectively valid recommendation.

Table 1b Assessment of findings after a more detailed examination *)

Legionellae **(CFU/100 ml)** [1)]	**Assessment**	**Measure**	**More detailed examination**	**Follow-up examination**
> 10000	Extremely high contamination	Directly necessary to ward off danger (disinfection and restriction of use, e.g. ban on showering) Rehabilitation necessary	Immediately	1 week after disinfection or rehabilitation
> 1000	High contamination	Short-term rehabilitation required	Within max. 3 months	1 week after disinfection or rehabilitation [2)]
≥ 100	Average contamination	Medium-term rehabilitation required	Within max. 1 year	1 week after disinfection or rehabilitation [2)]
< 100	No detectable / slight contamination	None	-	After 1 year (after 3 years) [3)]

[1)] CFU colony forming unit

[2)] If less than 100 L*egionellae* in 100 ml are demonstrated during two follow-up examinations at 3-monthly intervals, the next follow-up examination only needs to be carried out 1 year after the second follow-up examination. These follow-up examinations can be carried out in accordance with the pattern of an orientation examination (table 1a).

[3)] If less than 100 L*egionellae* in 100 ml are demonstrated during follow-up examinations at 12-monthly intervals, the examination interval may be extended to max. 3 years.

*) Examinations and assessments have to be performed in accordance with the Federal Environmental Agency's respectively valid recommendation.