

Managing Cooling Tower Hygiene

Operator duties, monitoring and measurement-led water hygiene under the 42. BImSchV

Control hygiene. Document operation.
Keep risks manageable.

The operator's task behind a stable cooling-water circuit

THE DECISION SEQUENCE

- 01 Classify the plant
- 02 Monitor the circuit
- 03 Respond to deviations
- 04 Verify and document

Evaporative cooling combines thermal performance with an open water circuit. Water quality, load, contact with air, wetted surfaces, cleaning, monitoring and record keeping interact. The plant is a changing water system with extensive surfaces and potential aerosol release, not an isolated piece of equipment.

Stable operation depends on the controlled interaction of design, water quality, operating method, cleaning, monitoring, response to deviations and reliable records. One chemical or one laboratory sample cannot provide that stability. The route is: classify the actual plant and its duties; turn operating and laboratory values into routines; manage deviations using a prepared decision process; and link causes, measures and effects in the records.

Four conclusions

Legal classification must be based on the actual plant type. Monitoring is an ongoing process rather than a calendar appointment. Water treatment has to be integrated into operation in a measurable way. Evidence and records are part of the technical performance.

Needs-based dosing requires suitable measurement points, defined target bands, checked material compatibility and a control strategy that reflects the real plant state. A complete operating log, traceable laboratory

reports, documented biocide addition and clear handling of changes turn a functioning installation into an auditable operation.

This report is for operators, plant and operations managers, facility and utilities managers, technical buyers, hygiene and HSE specialists, designers and consulting engineers.

Why evaporative cooling is demanding for hygiene

Evaporative cooling is efficient because some water evaporates and transfers heat to the air. That open contact also creates a hygiene challenge. The remaining water circulates repeatedly. Dissolved substances may concentrate as water is lost, while solids, organic matter and operational contamination add to the burden.

Biofilm amplifies operational problems

Microbial films can develop on wetted surfaces. Biofilm may make cleaning harder, distort readings, promote corrosion and impair heat transfer. Typical factors include changes in load, seasonal shutdowns, low-load operation, stagnation, dead zones, uneven flow, deposits, corrosion, organic inputs, unsuitable or poorly controlled biocide dosing, badly placed sampling points and gaps between operating data, laboratory findings and actions.

Under the 42nd Ordinance, classify the plant first

In everyday speech, many systems are called cooling towers. The legal term is narrower. The 42nd Federal Immission Control Ordinance (42. BImSchV) applies to evaporative cooling systems, cooling towers and wet separators in which water may be trickled, sprayed or otherwise brought into contact with the atmosphere.

A cooling tower as defined by the Ordinance is, in particular, a natural-draught system with a cooling capacity exceeding 200 MW per air outlet. Many

industrial recooling systems instead fall into the evaporative cooling system category. The difference matters because testing intervals and threshold values differ.

Basic design and operating requirements

Systems must be designed, built and operated so that contamination of process water by microorganisms, especially *Legionella*, is avoided in accordance with the state of the art. This includes appropriate materials and operating substances, minimal droplet emission, avoidance of dead zones, the ability to drain as completely as possible, dosing capability, suitable measurement and sampling arrangements, and regular maintenance.

Cooling capacity per air outlet is central to the statutory cooling tower definition. An interruption of the process-water circuit for more than one week triggers defined checks before restarting. The precise legal classification must always be made for the actual system against the current Ordinance.

Before first or renewed commissioning, carry out a risk assessment with hygiene expertise. Provide appropriate measurement points, sampling arrangements and recorded operating parameters. Assess changes to location, configuration or operation that may affect hygiene. Start every assessment with the plant ID, category, operating state and operating mode.

Turn a calendar into a dependable operating routine

For a typical evaporative cooling system, the basic rhythm is continuous observation of operating state and faults, internal checks at least every two weeks, laboratory tests for general colony count and *Legionella* at least every three months, the first routine laboratory test within four weeks after startup, an annual review of operation and risks, and an external inspection every five years.

The 42nd Ordinance requires internal checks of chemical, physical or microbiological parameters at least every two weeks. If the statutory conditions

are met and test value 1 has not been exceeded in two consecutive years, *Legionella* testing may move to a six-month interval. One sample must then be taken between 1 June and 31 August.

For legally defined cooling towers, internal checks are also required at least every two weeks, while laboratory testing for *Legionella* is at least monthly. After two consecutive years without an exceedance of test value 1, the interval may be extended to two months.

Make the testing calendar actionable

The calendar must state who is responsible and who deputises, identify measurement and sampling locations, define target and response bands, arrange laboratory commissioning, information routes and documentation deadlines, and connect testing with maintenance, cleaning, biocide addition and fault management. A measurement should lead to a defined operating decision rather than merely being stored in a file.

Data that support hygienically stable operation

A useful measurement concept starts with the operating conditions that need early detection. The Ordinance does not prescribe one universal set of online sensors for every plant. Relevant parameters depend on plant type, water chemistry, treatment concept, materials, load pattern and risks.

The position of a measurement point affects its meaning. A probe in a well-flushed location may show a stable value while a poorly supplied area deviates. Plant knowledge, a measurement-point plan and regular plausibility checks therefore belong together. Online data cannot replace laboratory testing or inspection. Their value is time resolution: they reveal trends, load changes, dosing responses and faults between laboratory results.

Conductivity can indicate concentration and support blowdown control. pH matters to water chemistry, materials and treatment effect. Temperature describes load and growth conditions.

Redox or residual measurements may support control and plausibility checks. Flow and runtime help describe pumps, dosing and operating state. Representative points, documented operating conditions and quality-assured laboratory results determine how well any of these data can be interpreted.

Classify and act on abnormal findings

For Legionella species, values are expressed as CFU per 100 ml. For evaporative cooling systems and wet separators, test value 1 is 100, test value 2 is 1,000 and the action value is 10,000. For cooling towers as legally defined by the Ordinance, the corresponding values are 500, 5,000 and 50,000. Classify the system before assessing the result.

An exceedance starts the statutory sequence of additional tests, investigation of causes, technical or operational measures and documentation. Exceedance of the action value requires, among other things, differentiation of Legionella, additional laboratory tests and, if confirmed, further measures to avert danger.

Agree the response before an incident

Define who receives a result, who decides on load reduction, cleaning, disinfection or shutdown, how causes are investigated and when a follow-up sample is taken. The competent authority must be informed without delay when the action value is exceeded; further details must be submitted within four weeks. Record actions, results and decisions in the operating log.

Source: 42. BImSchV, Annex 1 and sections 6 and 9, current version consulted August 2026.

Treatment, dosing and monitoring as one workflow

Choose treatment according to plant type, water chemistry, hygiene objective and verifiable performance under actual operating conditions. Plan make-up water supply, treatment, dosing, measurement, response and documentation as one sequence. Every step needs a defined purpose, a responsible role and a verifiable result.

There is no universal standard package. Before specifying the workflow, assess water chemistry, circuit volume, hydraulics, materials, existing conditioning, contamination sources, load pattern, blowdown, measurement points and the existing hygiene programme.

Measurement-led operation does not mean that one number captures the whole hygiene state. It means current data guide operation within a technically justified concept, make deviations visible and are checked independently. A sound control concept includes treatment capacity for normal and peak demand, safe integration with the circuit, a dosing point with demonstrable mixing, a representative sensor and suitable parameter, target and warning bands, an alarm and safe failure response, logged readings and dosing events, and regular verification by inspections and laboratory tests. Include material compatibility, current operating substances and the plant manufacturer's requirements.

Process data become evidence only in context

Automation does not remove operator responsibility. It can stabilise processes and make plant condition more traceable. Staff should be able to see what was measured, what control decision followed, how much was dosed and whether the plant was in the intended operating state.

A useful record links time and plant ID, value and measurement point, setpoint and deviation, dosing quantity, pump runtime and plant state, alarms and corrective actions, laboratory results and biocide

information, and maintenance and calibration events.

The operating log may be electronic, but must remain accessible and available in readable form. Define export, user rights, backup, retention and change history during integration. A proprietary dashboard without an understandable export is weak evidence. Well-designed automation maintains target bands, warns early and leaves an intelligible audit trail. Trends in conductivity, make-up water, blowdown, chemical consumption, faults and laboratory findings show whether stability is improving or the plant is merely reacting briefly.

Hygienic stability begins before routine operation

Construction, alteration, first filling, shutdown and restarting can generate problems that do not arise in stable operation. Commissioning starts a controlled verification period. Before first or renewed commissioning, the Ordinance requires defined checks involving hygiene expertise: remove contamination and residues, assess make-up water, commission existing treatment, inspect hygiene-relevant construction, instruct operating personnel and document the work.

Restarting after draining or an interruption of the water circuit longer than one week needs a specific plan connecting engineering, hygiene, sampling and records. Simply switching a pump back on is insufficient.

Assess new or moved pipes, basins, pumps, nozzles and sensors; changed loads, hours or seasonal modes; a different make-up water source, treatment or operating substance; changes to blowdown, concentration, biocide strategy or controls; and replacement fill or drift eliminator work. Arrange the first laboratory test within four weeks of commissioning or recommissioning. Before release, give every change a hygiene assessment, test plan and named owner.

Respond quickly without skipping the cause analysis

Keep technical faults, emerging hygiene concerns and laboratory-confirmed exceedances distinct. A pump, sensor, dosing, blowdown, ventilation or data fault requires a defined safe state, with substitute measurements and manual procedures according to prepared rules. Trend changes, visible deposits, unusual turbidity or unfavourable conditions warrant early action, before a statutory value is exceeded. Confirmed laboratory exceedances require the tests, investigation, measures and notifications appropriate to the plant category and value.

Short-term disinfection can reduce an acute burden, but will not automatically eliminate stagnation, dead zones, fouling, incorrect blowdown, poor measurement points or an unsuitable control strategy. Documented verification of effectiveness is needed to close the event technically.

Auditability is part of proper operation

The operating log connects the plant, personnel, laboratory and authority. It must be current, complete, legible and available. Keep it for five years from the last entry. The next external inspection is due on the statutory five-year cycle. File storage without a recognisable decision chain is as weak as stable operation without evidence.

The log should contain plant ID, location, operator, category and commissioning date; changes, restarts, shutdowns and operating states; internal checks and full laboratory reports; exceedances, causes, measures and follow-up values; timing, quantity and type of biocide addition; and faults, cleaning, maintenance and calibration.

Proper operation must be reviewed every five years by a publicly appointed and sworn expert or an accredited type A inspection body. Results must be communicated to the operator and competent

authority within four weeks of completion. A useful management measure is the proportion of deviations for which cause, decision, action and verification can be traced, rather than the number of data points stored.

From survey to stable measurement-led operation

Modernisation should begin with a reliable survey. First bring together plant category, risk assessment, diagram, water chemistry, load profile, operating mode, laboratory history, maintenance, dosing strategy and available data. Then specify sensors, target bands, alarms, sampling points, dosing location, production capacity and data interfaces.

Start the plant in stages under defined conditions. Verify sensor operation, dosing, mixing, alarms and logging. Compare operating and laboratory findings with the baseline. Adjust target bands and controls only with a clear reason. Then transfer the testing calendar, maintenance, calibration, laboratory commissioning and management review into normal operation. At least annually, assess whether changes or recurring deviations require an update.

The five phases are classification, concept, startup, verification and routine operation. Name gaps as open issues rather than hiding them in assumptions. Every phase needs a defined result, responsible role and evidence before the next begins.

Conclusion

Evaporative cooling systems remain dynamic. Water quality, load, environment, incoming materials and operating states change. Hygienic stability must therefore be managed continuously: classify the plant correctly, assess risks, monitor meaningful parameters, control treatment according to need, commission laboratory tests on time, respond to deviations and document each decision.

Voigtländer combines on-site analyte generation with dosing, measurement and recordable

operation; any design must be specific to the plant. Hydreatio supports operators and technical decision makers with surveys, assessment and an independent view of the whole system. The next step is a technical classification of the actual installation, its available water and operating data, hygiene and documentation gaps, and representative sampling locations.

Sources: German Ordinance on Evaporative Cooling Systems, Cooling Towers and Wet Separators (42. BImSchV), current version, Gesetze im Internet; German Environment Agency, Legionella detection in evaporative cooling systems.

Editorial status: August 2026. This report provides technical guidance and does not replace a plant-specific risk assessment, legal advice, official instructions, manufacturer requirements or a competent hygiene professional.

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