

2.13 Hygiene requirements for recreational water (Coastal and freshwater, swimming pools and spas)

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SUMMARY: *Recreational water may contribute to the transmission of infectious diseases. This is particularly true if the infectious dose of the pathogen necessary for contracting disease is low. The risk of infection decreases if recreational water is of good quality. In swimming pools this may be achieved by water treatment and disinfection. The hygienic risk associated with bathing may be minimised if all current hygiene requirements are complied with and good technical practice is observed.*

Swimming and bathing are popular leisure activities of high recreational value and health-promoting significance. For bathers to enjoy this activity without any risks, recreational water must be clean and impeccable, and satisfy specific hygiene requirements, among others. These requirements are designed to ensure that pathogens and other material introduced to the water by bathers or from the environment do not adversely affect bathers' health temporarily or permanently. Bathing is possible in so-called »free« (natural) bathing areas (coastal water, lakes and rivers) as well as in man-made swimming and bathing pools (indoor pools, outdoor pools, small pools or bioponds). As environmental and technical conditions vary, specific hygiene requirements have to be defined for each of these types of recreational water. Important criteria for all requirements on the quality of recreational water are defined in international guidelines (e.g. EU BATHING WATER DIRECTIVE 1975), the German Infection Protection Act (IfSG 2000), technical rules (e.g. DIN 19643 1997) and recommendations issued by expert bodies (e.g. guidelines of the World Health Organisation – WHO; recommendations of the German Bathing Water Commission). Protection of natural bathing water against external impacts, such as wastewater discharges from the catchment area, treatment of pool water, and effective monitoring of bathing water quality require technically demanding and costly measures. Protection of bathers against pathogens plays a key role in these efforts, as required by the Infection Protection Act (IfSG 2000) for swimming and bathing pool water.

Natural bathing water

Natural bathing water is influenced by many and varied uses as well as by discharges from surrounding areas. As a result, virtually all natural bathing waters are contaminated by faeces to varying degrees. Viruses, bacteria, monads and the eggs of various worms enter the water indirectly, via wastewater and rainwash, or directly via bathers. Noro-, entero-, astro-, adenoviruses and the agent of Hepatitis A are major representatives of viral pathogens in water. Pathogenic bacteria include the agents of typhus, enteritis salmonellae, campylobacters, shigellae, yersiniae, vibrios,

aeromonads, among others. Disease may also be caused by pathogenic eukaryotic monads such as giardia and cryptosporidians.

The main sources of contamination of bathing water are discharges from wastewater treatment plants and settlements, diffuse agricultural runoff, stormwater discharges, discharges from shipping, and the bathers themselves. Since it is not practicable to identify all pathogens and determine their concentrations in bathing water, assessment of the sanitary, microbiological quality of bathing water relies on analysis for a few bacteria species – so-called indicators, used to monitor drinking and bathing water –, which have the intestinal tract as their natural habitat and are excreted via faeces. These indicators for monitoring drinking and bathing water are *E. coli* and intestinal enterococci (IE). Limit values have been defined for the permitted concentration of these indicators in bathing water, in order to protect bathers against an unreasonably high risk of contracting disease.

Drinking water is not permitted to contain *E. coli* and enterococci in a 100 ml sample (DRINKING WATER ORDINANCE 2001). It would be unrealistic to apply the risk minimisation principle that holds for drinking water equally to bathing water. If clearance for bathing was given only to those natural bathing waters in which *E. coli* is not detectable in 100 ml (limit value for drinking water), we would have very few bathing areas in Europe.

Directive 76/160/EEC (»Bathing Water Directive«)

Evaluation of the quality of natural bathing water calls for an assessment of the risk of infection which bathers incur when the water is contaminated by faeces. Legislators may then take a political decision as to what risk – and what associated level of faecal contamination – seems acceptable. The microbiological limit and guide values of the current EU BATHING WATER DIRECTIVE, 76/160/EEC, are not, however, based on such a risk analysis, but instead were defined 30 years ago in line with then-existing national limit values. The microbiological guide and limit values of the Bathing Water Directive are listed in Table 2.13-1.

Table 2.13-1: Microbiological parameters in the current EU Bathing Water Directive (* to be evaluated only »on suspicion«)

Parameter	Guide value	Mandatory value	Minimum sampling frequency
Total coliforms/100 ml	500	10,000	fortnightly
Faecal coliforms/100 ml	100	2,000	fortnightly
Faecal streptococci/100 ml*	100	-	(2)
Salmonella/litre*	-	0	(2)
Enteroviruses PFU/10 litres*	-	0	(2)

The quality of German bathing waters has steadily improved in recent years (Fig. 2.13-1).

Planned revision of the EU Bathing Water Directive

The principles of the planned revision of the Bathing Water Directive have been published by the EU in several

statements of intent and preliminary drafts. The revised version differs in several respects from the Directive currently in force. Two of them are addressed below: New criteria for the assessment of bathing sites as well as short- and long-term measures for protection of bathers' health.

Assessment of bathing sites

The Bathing Water Directive currently in force evaluates bathing waters on the basis of the number of deviations from the microbiological and chemical limit values. This means that classification is oriented towards water quality in the preceding bathing season. The proposed revision provides for two different criteria for future assessment:

- Number of deviations from limit values (as before).
- Potential risks (wastewater discharges, stormwater discharges, wastewater overflow, etc.) at the bathing site (»beach profile«).

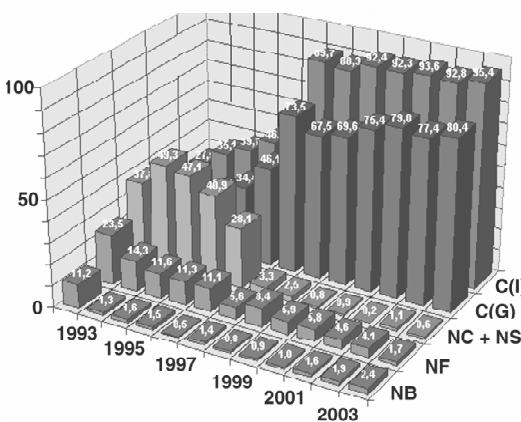
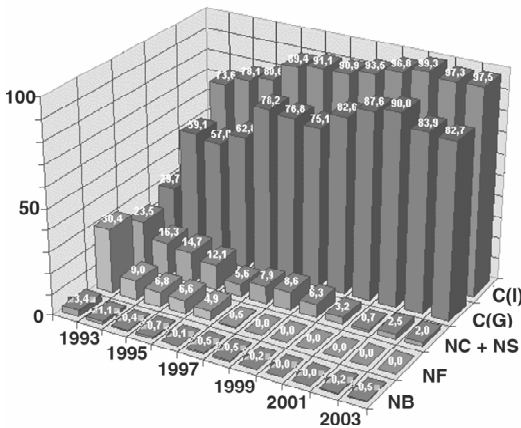


Fig. 2.13-1: Development of the quality of German bathing water since 1992. Upper graph: Coastal waters. Lower graph: Inland waters. Abbreviations: C(G), compliant with guide values; C(I), compliant with mandatory values; NC, non-compliant with mandatory values; NS, bathing areas not sampled; NF, bathing areas not sufficiently sampled; NB, bathing prohibited.

Furthermore, the EU proposal seeks to define limit values that are health oriented. These are values to which a certain health risk is assigned. Allocation was based on epidemiological studies establishing a relation between the concentration of bacterial indicators in bathing water and the incidence of illness among bathers. On this question, the EU followed the recommendations given by the WHO and has proposed the limit values shown in Table 2.13-2.

Measures to be taken by operators in case bathing water is not safe

The proposal provides that immediate measures are to be initiated if events affecting the water give reason to fear that bathers' health may be at risk. The list of immediate measures must be included in a »beach management plan« that has to be drawn up. Such measures may include, for

Table 2.13-2: Limit values in the EU proposal (cfu = colony forming units).

Parameter	Quality	
	Excellent	Good
Intestinal enterococci (cfu/100 ml)	100	200
<i>Escherichia coli</i> (cfu/100 ml)	250	500

example, a pre-planned bather information campaign by the local authorities. Long-term measures designed to reduce the health risk are:

- Construction of wastewater disposal facilities (e.g. a circular main)
- Administrative measures (e.g. prohibiting land-spreading of slurry in a catchment area)
- Issuing bathing bans and warnings on days with increased risk, e.g. after heavy rainfall discounting.

Economic significance of natural bathing waters

Beach tourism is an important source of income for many countries, including in particular those in southern Europe. But also in Germany tourism is a sizeable economic sector.

One social aspect of tourism is that every year vacationers from prosperous countries visit regions that are often socially disadvantaged. Economic prosperity is thus being transferred from rich to poorer countries. If these do not succeed in guaranteeing an acceptable quality of their bathing waters, there is the risk that vacationers may become infected and »bring home« diseases, mostly gastro-intestinal. This and other reasons justify the demand that the hygiene status of bathing water should generally meet the needs of technologically highly developed countries. It is certainly reasonable that the financial resources spent to keep bathing waters clean should match the importance of the recreational value of this economic sector.

Bathing pools in general

Swimming and bathing pools are man-made for bathing purposes, in contrast to natural bathing waters. Pathogens are introduced to pools almost exclusively via the pool users themselves, since only potable water may be used as pool water. Therefore, pool water is treated to remove micro-organisms, other organic pollution and other contaminations introduced to the water by pool users.

The treatment may be by nearly natural methods (small bathing ponds, man-made swimming and bathing pond systems) or by combinations of technical processes including disinfection (disinfected pools according to DIN 19643). The risk of infection during pool use can be minimised through appropriate requirements on water quality, operation and control.

Small bathing ponds

Hygiene standards for small bathing ponds were formulated in 2003 in a Recommendation of the Federal Environmental Agency (Umweltbundesamt – UBA), because the requirements to be applied to these types of man-made swimming and bathing pond systems differ

from those for natural bathing waters or disinfected pools. Small bathing ponds within the meaning of the UBA Recommendation are man-made outdoor swimming and bathing pond systems. They are sealed against the underlying soil, and the pond water is treated exclusively by biological and mechanical methods, and not by disinfection.

In small bathing ponds, any impairment of the hygienic quality of the water stems almost exclusively from the bathers themselves. Pond users may excrete pathogens in high concentrations which may exceed the concentrations of indicator organisms. On the other hand, treatment of the water by nearly natural methods – using gravel/sand filters or helophyte beds – is a very slow process. For these reasons, the maximum values for the microbiological monitoring parameters have to be stricter than those set in the EU Directive for natural bathing waters (Table 2.13-3). The microbiological standards were proposed by different groups of experts, having regard to the principle of anticipatory health protection, and have also been accepted by the Federal Environmental Agency’s Bathing Water Commission.

Pseudomonas aeruginosa was included as a parameter because it may occur in small, nutrient-rich lakes, is not indicated by *E. coli* and enterococci and can multiply in biofilms forming on the water treatment units.

In addition to stricter microbiological standards, the Recommendation contains hygiene-related requirements for chemical substances, particularly total phosphorus, visibility, water temperature and water treatment. Water treatment must be capable of removing pathogens that are not inactivated by biological processes in the pond. In addition, it is important that a sufficient amount of freshwater per bather be supplied to the bathing pond and that circulation encompasses the entire volume of the pond.

Another requirement is the posting of a warning at the bathing site that an increased risk to bathers’ health cannot be excluded, due to the fact that the pond water is not disinfected, and that this risk increases with the density of bathers. For the same reason, designated bathing areas for children are required to take the form of a separate pool constructed and operated in accordance with DIN 19643 (i.e., containing disinfected water).

In order to implement the above hygiene requirements, a set of technical rules was published in 2003 (FLL-Regelwerk 2003). As well as hygienic/microbiological water

Table 2.13-3: Microbiological water quality requirements for small bathing ponds (after UBA 2003).

<i>Parameter</i>	<i>Maximum value</i>
<i>E. coli</i>	100/100 ml
<i>Enterococci</i>	50/100 ml
<i>P. aeruginosa</i>	10/100 ml

Table 2.13-4: Requirements for clear water and pool water (DIN 19643).

Parameter	Unit	Clear water		Pool water	
		Lower value	Upper value	Lower value	Upper value
<i>Pseudomonas aeruginosa</i>	1/(100 ml)	-	n.d.	-	n.d.
<i>E. coli</i>	1/(100 ml)	-	n.d.	-	n.d.
<i>Legionella spec.</i>	1/ml 1/(100 ml)	-	n.d. ¹⁾	--	n.d. ²⁾
CFU at (20 ± 2)° C	1/ml	-	20	-	100
CFU at (36 ± 1)° C	1/ml	-	20	-	100

¹⁾ in filtrate at pool water temperatures ≥ 23° C

²⁾ in the water of hot-water whirlpools and pools with additional aerosol-forming water cycles and pool water temperatures ≥ 23° C n.d. = not detectable CFU = colony-forming units

quality criteria, they include general requirements for the planning, construction, operation and monitoring of small bathing ponds.

Swimming and bathing pools (according to DIN 19643)

As with small bathing ponds, the main source of pathogen input to these pools are the bathers. In order to prevent infection via pool water, pathogens thus introduced as well as other possible contaminations have to be eliminated or inactivated by continuous water treatment and disinfection. The hygienic quality of swimming and bathing pool water is dependent upon water flow through the pool, pool user density and the effectiveness of treatment.

It is crucial to have a flow regime which ensures an optimal distribution of the disinfectant and thus a sufficient disinfectant capacity everywhere throughout the pool, particularly near the water surface. Disinfection must ensure that any concentration of *Pseudomonas aeruginosa* is reduced by 4 powers of ten within a span of 30 seconds. To achieve this, a concentration of free chlorine between 0.3 and 0.6 mg/litre or, for hot-water whirlpools, between 0.7 and 1.0 mg/litre must be maintained in the pool water at all times.

This disinfection capacity ensures that a hygienically safe pool water quality can be achieved in all pools thus operated in accordance with DIN 19643 and that the risk of infection during pool use is kept as low as required by the Infection Protection Act.

In water quality monitoring, therefore, these pools must meet the strictest microbiological requirements as compared to small bathing ponds and natural bathing waters (Table 2.13-4). *Pseudomonas aeruginosa* is the most important parameter to monitor both pool water quality (as pathogen) and treatment (possible formation

of biofilms in filter systems) as well as for verifying the effectiveness of disinfection. Direct analysis for legionella is necessary as it is not covered by the parameters of the indicator system.

Since there are new technical systems which are operated with warm water and can generate aerosols, a specific risk of infection by legionella cannot be excluded. These technical systems, as well, have to be operated according to accepted standards in order to minimise the risk of infection. Measures have to be initiated as soon as microbiological limit values have been exceeded (pool closure, bathing ban, high-dose chlorination, filter backwashing, follow-up samples).

Monitoring

In addition to monitoring by the health authority (medical officer), there is the obligation for every operator of a pool, a bathing pond or a natural bathing site to carry out regular checks, particularly of pool/bathing water quality, or to arrange to have such checks carried out. The frequency of the investigations is indicated in the EU Bathing Water Directive, the DIN 19643 standard and other technical rules or in recommendations of the Bathing Water Commission.

Conclusion

Recreational water may contribute to the transmission of infectious diseases. This is particularly true if the infectious dose of the pathogen necessary for contracting disease is low. The risk of infection decreases if recreational water is of good quality. In swimming pools this may be achieved by water treatment and disinfection. The hygienic risk associated with bathing may be minimised if all current hygiene requirements are complied with and good technical practice is observed ♦