



Guidelines for drinking-water quality, third edition

Volume 1 - Recommendations

The first and second editions of the WHO Guidelines for Drinking-water Quality were used by developing and developed countries worldwide as the basis for regulation and standard setting to ensure the safety of drinking-water. They recognized the priority that should be given to ensuring microbial safety and provided guideline values for a large number of chemical hazards.

This third edition of the Guidelines has been comprehensively updated to take account of developments in risk assessment and risk management. It describes a "Framework for Drinking-water Safety" and discusses the roles and responsibilities of different stakeholders, including the complementary roles of national regulators, suppliers, communities and independent "surveillance" agencies.

Developments in this edition of the Guidelines include significantly expanded guidance on ensuring the microbial safety of drinking-water — in particular through comprehensive system-specific "water safety plans". Information on many chemicals has been revised to account for new scientific information and information on chemicals not previously considered has been included. For the first time, reviews of many waterborne pathogens are provided.

Recognizing the need for different tools and approaches in supporting large and community supplies, this edition continues to describe the principal characteristics of the approaches to each. New sections deal with the application of the Guidelines to specific circumstances, such as emergencies and disasters, large buildings, packaged/bottled water, travellers, desalination systems, food production and processing and water safety on ships and in aviation.

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a clear excess risk of adverse skeletal effects for a total intake of 14 mg/day and suggestive evidence of an increased risk of effects on the skeleton at total fluoride intakes above about 6 mg/day.

History of guideline development

The 1958 and 1963 WHO *International Standards for Drinking-water* referred to fluoride, stating that concentrations in drinking-water in excess of 1.0–1.5 mg of fluorine per litre may give rise to dental fluorosis in some children, and much higher concentrations may eventually result in skeletal damage in both children and adults. To prevent the development of dental caries in children, a number of communal water supplies are fluoridated to bring the fluorine concentration to 1.0 mg/litre. The 1971 *International Standards* recommended control limits for fluorides in drinking-water for various ranges of the annual average of maximum daily air temperatures; control limits ranged from 0.6–0.8 mg/litre for temperatures of 26.3–32.6 °C to 0.9–1.7 mg/litre for temperatures of 10–12 °C. In the first edition of the *Guidelines for Drinking-water Quality*, published in 1984, a guideline value of 1.5 mg/litre was established for fluoride, as mottling of teeth has been reported very occasionally at higher levels. It was also noted that local application of the guideline value must take into account climatic conditions and higher levels of water intake. The 1993 *Guidelines* concluded that there was no evidence to suggest that the guideline value of 1.5 mg/litre set in 1984 needed to be revised. It was also recognized that in areas with high natural fluoride levels, the guideline value may be difficult to achieve in some circumstances with the treatment technology available. It was also emphasized that in setting national standards for fluoride, it is particularly important to consider climatic conditions, volume of water intake and intake of fluoride from other sources.

Assessment date

The risk assessment was conducted in 2003.

Principal references

- IPCS (2002) *Fluorides*. Geneva, World Health Organization, International Programme on Chemical Safety (Environmental Health Criteria 227).
- WHO (2003) *Fluoride in drinking-water. Background document for preparation of WHO Guidelines for drinking-water quality*. Geneva, World Health Organization (WHO/SDE/WSH/03.04/96).

12.64 Formaldehyde

Formaldehyde occurs in industrial effluents and is emitted into air from plastic materials and resin glues. Formaldehyde in drinking-water results primarily from the oxidation of natural organic matter during ozonation and chlorination. It is also found in drinking-water as a result of release from polyacetal plastic fittings.

GUIDELINES FOR DRINKING-WATER QUALITY

Guideline value	0.9 mg/litre
Occurrence	Concentrations of up to 30 µg/litre have been found in ozonated drinking-water.
TDI	150 µg/kg of body weight, derived from a NOAEL (for a variety of effects, including increased relative kidney weights in females and an increased incidence of renal papillary necrosis in both sexes) of 15 mg/kg of body weight per day in a 2-year study in rats, incorporating an uncertainty factor of 100 (for intra- and interspecies variation); no account was taken of potential carcinogenicity from the inhalation of formaldehyde from various indoor water uses, such as showering
Limit of detection	6.2 µg/litre by HPLC following derivatization with 2,4-dinitrophenylhydrazine and liquid-solid extraction
Treatment achievability	<0.03 mg/litre by process control/modification
Guideline derivation	
• allocation to water	20% of TDI
• weight	60-kg adult
• consumption	2 litres/day

Toxicological review

Rats and mice exposed to formaldehyde by inhalation exhibited an increased incidence of carcinomas of the nasal cavity at doses that caused irritation of the nasal epithelium. Ingestion of formaldehyde in drinking-water for 2 years caused stomach irritation in rats. Papillomas of the stomach associated with severe tissue irritation were observed in one study. IARC has classified formaldehyde in Group 2A. The weight of evidence indicates that formaldehyde is not carcinogenic by the oral route.

History of guideline development

The 1958, 1963 and 1971 WHO *International Standards for Drinking-water* and the first edition of the *Guidelines for Drinking-water Quality*, published in 1984, did not refer to formaldehyde. The 1993 Guidelines established a health-based guideline value of 0.9 mg/litre for formaldehyde in drinking-water.

Assessment date

The risk assessment was originally conducted in 1993. The Final Task Force Meeting in 2003 agreed that this risk assessment be brought forward to this edition of the *Guidelines for Drinking-water Quality*.

Principal reference

WHO (2003) *Formaldehyde in drinking-water. Background document for preparation of WHO Guidelines for drinking-water quality*. Geneva, World Health Organization (WHO/SDE/WSH/03.04/48).