

Arsenic in Drinking-water

Background document for development of
WHO *Guidelines for Drinking-water Quality*

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Preface

One of the primary goals of WHO and its member states is that “all people, whatever their stage of development and their social and economic conditions, have the right to have access to an adequate supply of safe drinking water.” A major WHO function to achieve such goals is the responsibility “to propose ... regulations, and to make recommendations with respect to international health matters”

The first WHO document dealing specifically with public drinking-water quality was published in 1958 as *International Standards for Drinking-water*. It was subsequently revised in 1963 and in 1971 under the same title. In 1984–1985, the first edition of the WHO *Guidelines for Drinking-water Quality* (GDWQ) was published in three volumes: Volume 1, Recommendations; Volume 2, Health criteria and other supporting information; and Volume 3, Surveillance and control of community supplies. Second editions of these volumes were published in 1993, 1996 and 1997, respectively. Addenda to Volumes 1 and 2 of the second edition were published in 1998, addressing selected chemicals. An addendum on microbiological aspects reviewing selected microorganisms was published in 2002.

The GDWQ are subject to a rolling revision process. Through this process, microbial, chemical and radiological aspects of drinking-water are subject to periodic review, and documentation related to aspects of protection and control of public drinking-water quality is accordingly prepared/updated.

Since the first edition of the GDWQ, WHO has published information on health criteria and other supporting information to the GDWQ, describing the approaches used in deriving guideline values and presenting critical reviews and evaluations of the effects on human health of the substances or contaminants examined in drinking-water.

For each chemical contaminant or substance considered, a lead institution prepared a health criteria document evaluating the risks for human health from exposure to the particular chemical in drinking-water. Institutions from Canada, Denmark, Finland, France, Germany, Italy, Japan, Netherlands, Norway, Poland, Sweden, United Kingdom and United States of America prepared the requested health criteria documents.

Under the responsibility of the coordinators for a group of chemicals considered in the guidelines, the draft health criteria documents were submitted to a number of scientific institutions and selected experts for peer review. Comments were taken into consideration by the coordinators and authors before the documents were submitted for final evaluation by the experts meetings. A “final task force” meeting reviewed the health risk assessments and public and peer review comments and, where appropriate, decided upon guideline values. During preparation of the third edition of the GDWQ, it was decided to include a public review via the world wide web in the process of development of the health criteria documents.

During the preparation of health criteria documents and at experts meetings, careful consideration was given to information available in previous risk assessments carried out by the International Programme on Chemical Safety, in its Environmental Health Criteria monographs and Concise International Chemical Assessment Documents, the International Agency for Research on Cancer, the joint FAO/WHO Meetings on Pesticide Residues and the joint FAO/WHO Expert Committee on Food Additives (which evaluates contaminants such as lead, cadmium, nitrate and nitrite, in addition to food additives).

Further up-to-date information on the GDWQ and the process of their development is available on the WHO internet site and in the current edition of the GDWQ.

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The work of the following working group coordinators was crucial in the development of this document and others in the third edition:

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The contribution of peer reviewers is greatly appreciated. The draft text was posted on the world wide web for comments from the public. The revised text and the comments were discussed at the Final Task Force Meeting for the third edition of the GDWQ, held on 31 March to 4 April 2003, at which time the present version was finalized. The input of those who provided comments and of participants in the meeting is gratefully reflected in the final text.

The WHO coordinators were as follows:

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Ms Marla Sheffer of Ottawa, Canada, was responsible for the scientific editing of the document.

Many individuals from various countries contributed to the development of the GDWQ. The efforts of all who contributed to the preparation of this document and in particular those who provided peer or public domain review comment are greatly appreciated.

Acronyms and abbreviations used in the text

CAS	Chemical Abstracts Service
DMA	dimethylarsinic acid
DNA	deoxyribonucleic acid
IARC	International Agency for Research on Cancer
ICP-MS	inductively coupled plasma mass spectrometry
MMA	monomethylarsonic acid

Table of contents

1. GENERAL DESCRIPTION	1
1.1 Identity	1
1.2 Physicochemical properties	1
1.3 Major uses.....	1
1.4 Environmental fate.....	2
2. ANALYTICAL METHODS	2
3. ENVIRONMENTAL LEVELS AND HUMAN EXPOSURE.....	2
3.1 Air	2
3.2 Water.....	2
3.3 Food	2
3.4 Estimated total exposure and relative contribution of drinking-water.....	3
4. KINETICS AND METABOLISM IN LABORATORY ANIMALS AND HUMANS	3
5. EFFECTS ON LABORATORY ANIMALS AND <i>IN VITRO</i> TEST SYSTEMS ...	4
5.1 Long-term exposure.....	4
5.2 Reproductive and developmental toxicity	4
5.3 Mutagenicity and related end-points.....	4
5.4 Carcinogenicity	5
6. EFFECTS ON HUMANS.....	5
7. PROVISIONAL GUIDELINE VALUE.....	7
8. REFERENCES	7

1. GENERAL DESCRIPTION

1.1 Identity

Arsenic exists in oxidation states of -3, 0, 3 and 5. It is widely distributed throughout the Earth's crust, most often as arsenic sulfide or as metal arsenates and arsenides. In water, it is most likely to be present as arsenate, with an oxidation state of 5, if the water is oxygenated. However, under reducing conditions (<200 mV), it is more likely to be present as arsenite, with an oxidation state of 3 (IPCS, 2001).

Compound	CAS No.	Molecular formula
Arsenic	7440-38-2	As
Arsenic trioxide	1327-53-3	As ₂ O ₃
Arsenic pentoxide	1303-28-2	As ₂ O ₅
Arsenic sulfide	1303-33-9	As ₂ S ₃
Dimethylarsinic acid (DMA)	75-60-5	(CH ₃) ₂ AsO(OH)
Monomethylarsonic acid (MMA)	124-58-3	(CH ₃)AsO(OH) ₂
Lead arsenate	10102-48-4	PbHAsO ₄
Potassium arsenate	7784-41-0	KH ₂ AsO ₄
Potassium arsenite	10124-50-2	KAsO ₂ HAsO ₂

1.2 Physicochemical properties (IARC, 1980; Lide, 1992–1993)

Compound	Melting point (°C)	Boiling point (°C)	Density (g/cm ³)	Water solubility (g/litre)
As	613	–	5.727 at 14 °C	insoluble
As ₂ O ₃	312.3	465	3.738	37 at 20 °C
As ₂ O ₅	315 (decomposes)	–	4.32	1500 at 16 °C
As ₂ S ₃	300	707	3.43	5 × 10 ⁻⁴ at 18 °C
(CH ₃) ₂ AsO(OH)	200	–	–	829 at 22 °C
CH ₃ AsO(OH) ₂	–	–	–	–
PbHAsO ₄	720 (decomposes)	–	5.79	very slightly soluble
KH ₂ AsO ₄	288	–	2.867	190 at 6 °C
KAsO ₂ HAsO ₂	–	–	–	–

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