Data gaps include subchronic or chronic toxicity studies, multigeneration reproductive toxicity studies, standard developmental toxicity studies and carcinogenicity studies. The available data are considered inadequate to establish guideline values for these chemicals.

History of guideline development

Assessment date
The risk assessment was conducted in 2003.

Principal references

12.17 Cadmium
Cadmium metal is used in the steel industry and in plastics. Cadmium compounds are widely used in batteries. Cadmium is released to the environment in wastewater, and diffuse pollution is caused by contamination from fertilizers and local air pollution. Contamination in drinking-water may also be caused by impurities in the zinc of galvanized pipes and solders and some metal fittings. Food is the main source of daily exposure to cadmium. The daily oral intake is 10–35 µg. Smoking is a significant additional source of cadmium exposure.

<table>
<thead>
<tr>
<th>Guideline value</th>
<th>0.003 mg/litre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occurrence</td>
<td>Levels in drinking-water usually less than 1 µg/litre</td>
</tr>
<tr>
<td>PTWI</td>
<td>7 µg/kg of body weight, on the basis that if levels of cadmium in the renal cortex are not to exceed 50 mg/kg, total intake of cadmium (assuming an absorption rate for dietary cadmium of 5% and a daily excretion rate of 0.005% of body burden) should not exceed 1 µg/kg of body weight per day</td>
</tr>
<tr>
<td>Limit of detection</td>
<td>0.01 µg/litre by ICP/MS; 2 µg/litre by FAAS</td>
</tr>
<tr>
<td>Treatment achievability</td>
<td>0.002 mg/litre should be achievable using coagulation or precipitation softening</td>
</tr>
</tbody>
</table>
Guideline derivation
- allocation to water: 10% of PTWI
- weight: 60-kg adult
- consumption: 2 litres/day

Additional comments
- Although new information indicates that a proportion of the general population may be at increased risk for tubular dysfunction when exposed at the current PTWI, the risk estimates that can be made at present are imprecise.
- It is recognized that the margin between the PTWI and the actual weekly intake of cadmium by the general population is small, less than 10-fold, and that this margin may be even smaller in smokers.

**Toxicological review**
Absorption of cadmium compounds is dependent on the solubility of the compounds. Cadmium accumulates primarily in the kidneys and has a long biological half-life in humans of 10–35 years. There is evidence that cadmium is carcinogenic by the inhalation route, and IARC has classified cadmium and cadmium compounds in Group 2A. However, there is no evidence of carcinogenicity by the oral route and no clear evidence for the genotoxicity of cadmium. The kidney is the main target organ for cadmium toxicity. The critical cadmium concentration in the renal cortex that would produce a 10% prevalence of low-molecular-weight proteinuria in the general population is about 200 mg/kg and would be reached after a daily dietary intake of about 175 µg per person for 50 years.

**History of guideline development**
The 1958 WHO International Standards for Drinking-water did not refer to cadmium. The 1963 International Standards recommended a maximum allowable concentration of 0.01 mg/litre, based on health concerns. This value was retained in the 1971 International Standards as a tentative upper concentration limit, based on the lowest concentration that could be conveniently measured. In the first edition of the Guidelines for Drinking-water Quality, published in 1984, a guideline value of 0.005 mg/litre was recommended for cadmium in drinking-water. This value was lowered to 0.003 mg/litre in the 1993 Guidelines, based on the PTWI set by JECFA.

**Assessment date**
The risk assessment was conducted in 2003.

**Principal references**

**12.18 Carbofuran**

Carbofuran (CAS No. 1563-66-2) is used worldwide as a pesticide for many crops. Residues in treated crops are generally very low or not detectable. The physical and chemical properties of carbofuran and the few data on occurrence indicate that drinking-water from both groundwater and surface water sources is potentially the major route of exposure.

<table>
<thead>
<tr>
<th>Guideline value</th>
<th>0.007 mg/litre</th>
</tr>
</thead>
<tbody>
<tr>
<td>Occurrence</td>
<td>Has been detected in surface water, groundwater and drinking-water, generally at levels of a few micrograms per litre or lower; highest concentration (30 μg/litre) measured in groundwater</td>
</tr>
<tr>
<td>ADI</td>
<td>0.002 mg/kg of body weight based on a NOAEL of 0.22 mg/kg of body weight per day for acute (reversible) effects in dogs in a short-term (4-week) study conducted as an adjunct to a 13-week study in which inhibition of erythrocyte acetylcholinesterase activity was observed, and using an uncertainty factor of 100</td>
</tr>
<tr>
<td>Limit of detection</td>
<td>0.1 μg/litre by GC with a nitrogen–phosphorus detector; 0.9 μg/litre by reverse-phase HPLC with a fluorescence detector</td>
</tr>
<tr>
<td>Treatment achievability</td>
<td>1 μg/litre should be achievable using GAC</td>
</tr>
</tbody>
</table>

**Toxicological review**

Carbofuran is highly toxic after acute oral administration. The main systemic effect of carbofuran poisoning in short- and long-term toxicity studies appears to be cholinesterase inhibition. No evidence of teratogenicity has been found in reproductive toxicity studies. On the basis of available studies, carbofuran does not appear to be carcinogenic or genotoxic.

**History of guideline development**

The 1958 and 1963 WHO *International Standards for Drinking-water* did not refer to carbofuran, but the 1971 International Standards suggested that pesticide residues that may occur in community water supplies make only a minimal contribution to the total daily intake of pesticides for the population served. Carbofuran was not evaluated in the first edition of the *Guidelines for Drinking-water Quality*, published in 1984, but a