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Всемирная организация здравоохранения
Европейское региональное бюро

Chemical and Physical Parameters

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Why

- The standards in Annex I of the Directive are based broadly on the second edition of the WHO Guidelines.
- This was published in 1993 and there have been changes in knowledge and Guideline Values (GVs) for a number of the parameters plus WSPs.
- We now have a significant amount of data on occurrence that helps to identify where change **might** be appropriate.
- Need to focus on what is important for protecting public health and acceptability of water plus operations.

Chemicals in Drinking-water

- Very few have been shown to cause health effects from exposure through drinking-water.
  - *Arsenic* and *fluoride*.
  - *Nitrate (nitrite)* but not clear as affected by diarrhoea.
  - *Lead* at low levels but effects at low doses limited.
  - Possibly soluble *manganese*.
  - *Other parameters*: theoretical risk of effects.

WHO Guidelines

- “Threshold chemicals” based on the no observed effect level (NOEL) or benchmark dose in animal studies, or human epidemiology.
- Uncertainty factors are applied to tolerable daily intake (TDI).
  - Estimate of the amount of a substance in food and drinking-water, expressed on a body weight basis that can be ingested over a lifetime without appreciable health risk.
  - A proportion of the TDI is allocated to drinking-water to allow for exposure from other sources.
- GV is expected to be associated with no risk of adverse effects.

GVs for Possible Carcinogens

- Values for substances which **<u>may</u>** be carcinogenic mostly established by the application of mathematical models, usually the linearized multistage model.
- *These models do not usually take into account a number of biologically important considerations, such as pharmacokinetics, DNA repair or protection by the immune system. They also assume the validity of a linear extrapolation of very high dose exposures in test animals to very low dose exposures in humans. As a consequence, the models used are conservative (i.e. err on the side of caution).*

Possible Carcinogens

- GV is the upper bound of the risk associated with *1 additional cancer per 100,000 population* exposed to *2 litres of water per day* containing the substance at the GV for 70 years.
- Lower bound estimate often below zero.
- Do not represent number of lives saved.
- Costs and benefits?

WHO Guidelines for Chemicals - development

- A background document is prepared usually from a peer reviewed international review, e.g. JECFA, JMPR, or if that is not available an internationally recognised and peer reviewed national document, e.g. Health Canada. Last resort is a de novo review – takes time.
- Proposals reviewed by Guidelines expert committee by e-mail and discussed at meeting of the committee. Document and approach agreed. Finalised and re-reviewed by expert committee members.
- External peer review by experts. Document and guideline revised as necessary.
- “Public” consultation and revision if necessary. Finalised by expert committee.
- Published as a guideline.

Differences

Parameter	DWD	WHO	Date	Reason
Acrylamide	0.1	0.5	2011	ALARP
Antimony	5.0	20.0	2003	New data
Benzene	1.0	10.0	1993	Acceptable risk
Benzo(a)pyrene	0.01	0.7	1993	Different risk extrapolation
Boron	1000	2400	2009	New scientific data
Cadmium	5.0	3.0	2011	Rounding
Cyanide	50.0	-	2009	New assessment
1,2-Dichloroethane	3.0	30.0	2003	Acceptable risk
Epichlorohydrin	0.1	0.4	1993	?
Mercury	1.0	6.0	2004	New assessment

Differences (cont.)

Parameter	DWD	WHO	Date	Reason
Nickel	20.0	70.0	2004	New assessment
Nitrite	500	3000	2011	Control in distribution
Pesticides	0.1/0.5	individ.	various	Policy decision
Heptachlor etc	0.03	- & 0.3	2004	New data
PAH (4 substances)	0.1	-	1993	Basis
Selenium	10.0	40.0	2011	New assessment
Tri- & tetracloroethene	10.0	20/40	1993	?
Vinyl chloride	0.5	0.3	2004	rounding
THMs	100	ind	2004	bromodichloromethane
Lead	10	10	2004	Provisional ALARP

Needs

- Assess if parameters should be retained/removed from DWD Annex I using actual occurrence data and parametric/GV values.
- Consider new parameters, although much fewer systematic data on occurrence.
- Consider how best to configure parameters to take into account risk-based inclusion which varies across MS.
- Consider change of values in the light of new data.

Assessing Occurrence Data

- Key questions:
  - Percentage of MS and individual supplies in which a parameter is observed at above about 50% of parametric value/GV
  - Number of MS and supplies in which a parametric value is exceeded and percentage of supplies/samples in which this occurs (compliance)

Data Analysis

- Data received from 19 Member States and 27 water utilities from Finland, France, Germany, Italy & Sweden.

Member States		
Austria	Germany (3 states)	Romania
Belgium (3 states)	Hungary	Slovakia
Cyprus	Italy	Slovenia
Czech Republic	Lithuania	Spain
Denmark	Malta	United Kingdom
Estonia	Netherlands	
France	Portugal	

Data Analysis (cont.)

- Format not consistent (not a criticism).
- Needed to modify approach.
- Based largely on MS data supported by stakeholder data.

Approach

- Statistical scoring system based on exceedance and compliance data.
- For both exceedance and compliance final scores calculated and then categorised as low, medium and high priority for the considered action.
- Also considered health data and need for re-evaluation.
- Key parameters known to be of health significance automatically retained – arsenic, fluoride, nitrate/nitrite, lead. Pesticides not considered.

Results

Parameter	Group	Priority for removal
Acrylamide	Treatment	High – materials control
Antimony	Distribution	Medium/high
Benzene	Raw water	High
Benzo(a)pyrene	Distribution	High – dirty water
Boron	Raw water (desal)	Low
Bromate	Treatment	Uncertain – re-evaluation
Cadmium	Distribution	Medium
Chromium	Raw water	Medium – re-evaluation
Copper	Plumbing	Medium
Cyanide	Raw water	High – spills

Results (cont.)

Parameter	Group	Priority for removal
1,2-Dicloroethane	Raw water	High
Epichlorohydrin	Treatment	High – materials control
Lead	Plumbing	Low
Mercury	Raw water	High
Nickel	Raw water/taps	Medium
PAH	Distribution	High – dirty water
Selenium	Raw water	High
Tri- & tetrachloroethene	Raw water	High
THMs	Treatment	Low – if chlorination
Vinyl chloride	Materials	High – materials control

Possible New Parameters

Parameter	Source	WHO	Comment on inclusion
Chlorate	Treatment	700	Medium/high – hypochlorite
Chlorite	Treatment	700	Medium/high – ClO2
EDCs	Raw water	*N/A*	Low
Haloacetates	Treatment	*Various*	Medium/high – chlorination
Microcystin	Raw water	1.0	Low/medium – algal blooms
NDMA	Treatment	0.1	Low
PFOS/PFOA	Raw water	*in develop.*	Medium/high – historical
Pharmaceuticals	Raw water	-	Low
Uranium	Raw water	30.0	Low/medium but……..
Others	*Various*	*N/A*	*Low*

Grouping

- Raw water – naturally occurring
- Raw water – anthropogenic
- Distribution – different approach
- Plumbing – different approach to monitoring and control.
- Treatment
- Materials and chemicals used in supply

Possible Option

Group	Chemical	Primary control option	Monitoring
Raw water: *naturally occurring*	Arsenic, boron (particularly sea water), fluoride, chromium, nickel and selenium, (uranium, microcystin, manganese?)	Source selection and drinking-water treatment	At works in final water
Raw water: *anthropogenic origin*	Benzene, chromium, cyanide, 1,2-dichloroethane, mercury, nitrate/nitrite, pesticides, tetrachloroethene and trichloroethene, (Pfos/Pfoa),	Pollution control, source blending and drinking-water treatment	At works in final water
Distribution	Antimony, cadmium, polycyclic aromatic hydrocarbons and benzo(a)pyrene and vinyl chloride	Material selection and distribution management or by product control (vinyl chloride)	In distribution or at tap; by product control (vinyl chloride)
Internal plumbing (buildings)	Antimony, cadmium, copper, lead and nickel	Product specification and corrosion control	At tap by tailored representative monitoring programmes
Treatment	Acrylamide, bromate, epichlorohydrin, [added fluoride] and trihalomethanes,(HAAs, chlorate, chlorite)	Process control and product specification or by product control (acrylamide and epichlorohydrin)	At works in final water (fluoride and bromate); at tap (trihalomethanes); by product control (acrylamide and epichlorohydrin)

Indicator Parameters

- Important for acceptability but possible to be flexible.
- Manganese may also have health implications when present as soluble Mn but almost exclusively small supplies.
- Important operational parameters.
- Particularly aluminium and turbidity (possible to continuously monitor).
- Parameters such as chloride are easily monitored but can be replaced by conductivity which can be continuously monitored.

Discussion

- Monitoring and analysis carries a cost so it makes sense to minimise this cost in relation to the benefit. Measuring lots of zeros is not helpful and diverts resources.
- In the light of experience can streamline the parametric list to include the most important across MS.
- Need to consider updates of parametric values in the light of new data over the past 20+ years
- Need to identify new threats and determine whether these should be included.