

Revised Procedure for Converting Total Recoverable Water Quality Criteria for Metals to Dissolved Criteria



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REVISED PROCEDURE FOR CONVERTING TOTAL RECOVERABLE CRITERIA TO DISSOLVED CRITERIA

The correct conversion factor should include an additional factor which is the ratio of the acidification concentration to the total recoverable concentration. This factor when multiplied by the ratio of the dissolved concentration to the acidification concentration will result in the correct conversion factor as in the following formulas:

$$\text{Conversion Factor} = \frac{\text{Dissolved Concentration}}{\text{Total Recoverable Concentration}}$$

$$\text{Conversion Factor} = \frac{\text{Acidification Concentration}}{\text{Total Recoverable Concentration}} \times \frac{\text{Dissolved Concentration}}{\text{Acidification Concentration}}$$

The current factors are only the ratio of the dissolved concentration to the acidification concentration.

Acidification to total recoverable factors (A/T Factors) can be calculated from the data provided in the document. Separate A/T factors can be calculated for each combination of dilution water, food and metal combination, and the appropriate factor used to calculate final adjustment factors for each test.

An appropriate procedure that would follow the Aquatic Life Criteria Guideline Committee's recommendation for a time-weighted average would be to calculate the dissolved to acidification ratio for each species/test combination (i.e., test-specific conversion factor) using the following formulas:

$$TWA_{48} = \frac{\% \text{ dissolved at 1 hour} + \% \text{ dissolved at 48 hours}}{2}$$

and

$$TWA_{96} = \frac{\% \text{ dissolved}(1 \text{ hour}) + 2 \times \% \text{ dissolved}(48 \text{ hours}) + \% \text{ dissolved}(96 \text{ hours})}{4}$$

where:

TWA₄₈ = time-weighted average for 48 hour static tests.
 TWA₉₆ = time-weighted average for 96 hour static tests.
 % dissolved = the dissolved concentration at the specified time divided by the acidification concentration at 1 hour.

These formulas appear in Appendix K of the March 11, 1995 report entitled "Derivation of Conversion Factors for the Calculation of Dissolved Freshwater Aquatic Life Criteria for Metals". The mean of the time-weighted averages for the species that were important in the derivation of the

total recoverable criteria for each metal would then be the final conversion factor. Application of the revised procedure to the data for the seven metals that are proposed to be expressed as the dissolved form of the metal (cadmium, chromium, copper, lead, nickel and zinc) is as follows.

Copper

Since both *Daphnia* and the fathead minnow were used (58 of 124 tests) to derive the pooled slope for the criteria, data from all tests should be used.

Species	Food	A/T Factor	1 Hour	48 Hours	96 Hours	Time-Weighted Average*
Fathead Minnow	No	0.927	98.8	88.9	76.9	81.9
Fathead Minnow	No	0.927	99.0	87.5	87.1	83.7
<i>Daphnia magna</i>	Yeast/Trout Chow	0.996	97.4	99.9	-	98.3
<i>Daphnia magna</i>	Yeast/Trout Chow	0.996	90.6	94.3	-	92.1
Fathead Minnow	Brine shrimp	0.998	98.6	83.9	-	91.1
Fathead Minnow	Brine shrimp	0.998	100.0**	83.0	-	91.3
<i>D. magna</i> (200 mg/l hardness)	Yeast/Trout Chow	0.996	98.9	91.0	-	94.6
<i>D. magna</i> (200 mg/l hardness)	Yeast/Trout Chow	0.996	96.3	90.4	-	93.0
Final Average Value						90.8

* - Time-weighted averages as described in Appendix K for 48 hour static tests (1.) and 96 hour static tests (2.).

** - Value over 100. Assumed to be 100.

Zinc

Since most of the tests used to derive the pooled slope for the criteria used fish (90 of 109 tests), data from all tests should be used.

Species	Food	A/T Factor	1 Hour	48 Hours	96 Hours	Time-Weighted Average*
Fathead Minnow	No	1.125 ^{***}	98.3	98.3	92.4	96.8
Fathead Minnow	No	1.125 ^{***}	99.8	94.3	92.3	95.2
Daphnia magna	Yeast/Trout Chow	0.964	98.5	94.8	-	93.2
Daphnia magna	Yeast/Trout Chow	0.964	98.5	98.1	-	94.8
Final Average Value						95.0

* - Time-weighted averages as described in Appendix K for 48 hour static tests (1.) and 96 hour static tests (2.).

** - Value over 100. Assumed to be 100.

*** - Value over 1.0. Assumed to be 1.0.

Lead

Since both *Daphnia* and the fathead minnow were used (6 of 8 tests) to derive the pooled slope for the criteria, data from all tests should be used.

Species	Food	A/T Factor	1 Hour	48 Hours	96 Hours	Time-Weighted Average*
Fathead Minnow	No	1.037***	100.6**	78.1	66.0	80.6
Fathead Minnow	No	1.037***	104.4**	60.8	69.5	72.8
Fathead Minnow	No	1.037***	103.1**	71.1	70.2	78.1
<i>Daphnia magna</i> (50 mg/l hardness)	Yeast/Trout Chow	0.921	93.1	69.2	-	74.7
<i>D. magna</i> (50 mg/l hardness)	Yeast/Trout Chow	0.921	96.3	78.6	-	80.5
<i>D. magna</i> (200 mg/l hardness)	Yeast/Trout Chow	0.921	69.7	49.5	-	54.9
<i>D. magna</i> (200 mg/l hardness)	Yeast/Trout Chow	0.921	76.5	63.7	-	64.6
Final Average Value						72.3

* - Time-weighted averages as described in Appendix K for 48 hour static tests (1.) and 96 hour static tests (2.).

** - Value over 100. Assumed to be 100.

*** - Value over 1.0. Assumed to be 1.0.

Nickel

Since both *Daphnia* and the fathead minnow were used to derive the pooled slope for the criteria (16 of 24 tests), data from all tests should be used.

Species	Food	A/T Factor	1 Hour	48 Hours	96 Hours	Time-Weighted Average*
Fathead Minnow	No	0.889	100.3**	100.8**	101.5**	88.9
Fathead Minnow	No	0.889	104.0**	97.4	98.8	87.5
<i>Daphnia magna</i> (50 mg/l hardness)	Yeast/Trout Chow	0.850	102.4**	88.8	-	80.2
<i>D. magna</i> (50 mg/l hardness)	Yeast/Trout Chow	0.850	98.5	99.4	-	84.1
<i>D. magna</i> (50 mg/l hardness)	Yeast/Trout Chow	0.850	99.1	105.8**	-	84.6
<i>D. magna</i> (200 mg/l hardness)	Yeast/Trout Chow	0.850	99.6	98.0	-	84.0
<i>D. magna</i> (200 mg/l hardness)	Yeast/Trout Chow	0.850	99.0	97.2	-	83.4
<i>D. magna</i> (200 mg/l hardness)	Yeast/Trout Chow	0.850	98.2	101.4**	-	84.2
Final Average Value						84.6

* - Time-weighted averages as described in Appendix K for 48 hour static tests (1.) and 96 hour static tests (2.).

** - Value over 100. Assumed to be 100.

*** - Value over 1.0. Assumed to be 1.0.

Chromium (Trivalent)

The pooled slope was derived from tests with *Daphnia*, fathead minnows and bluegills although none of these species represent the four most sensitive species used to derive the final acute value? The chronic toxicity tests also did not show a statistically-significant relationship with hardness.

The recommended adjustment factor for chronic criteria was **not** based upon these results but on the % dissolved reported in the study which formed the basis for the criterion.

Species	Food	A/T Factor	1 Hour	48 hours	96 hours	T i m e - Weighted Average*
Fathead Minnow	No	1.00	71.1	17.7	44.4	37.7
Fathead Minnow	No	1.00	59.5	6.1	9.7	20.35
Fathead Minnow (200 mg/l hardness)	No	1.00	62.9	17.3	14.8	28.1
Fathead Minnow (200 mg/l hardness)	No	1.00	42.6	23.4	8.8	24.6
Final Value						27.7

Chromium (Hexavalent)

Three genera of Cladocerans (*Daphnia*, *Simocephalus* and *Ceriodaphnia*) were the most sensitive to hexavalent chromium.

Species	Food	A/T Factor	1 Hour	48 Hours	96 Hours	Time-Weighted Average*
Fathead Minnow	No	0.920	100.4**	95.0	93.8	88.3
Fathead Minnow	No	0.920	101.0**	99.1	100.2**	91.6
<i>Daphnia magna</i> (50 mg/l hardness)	Yeast/Trout Chow	1.035***	102.4**	91.7	-	95.9
<i>D. magna</i> (50 mg/l hardness)	Yeast/Trout Chow	1.035***	97.3	83.3	-	91.7
Final Average Value						91.9

* - Time-weighted averages as described in Appendix K for 48 hour static tests (1.) and 96 hour static tests (2.).

** - Value over 100. Assumed to be 100.

*** - Value over 1.0. Assumed to be 1.0.

Cadmium

A non-hardness dependent conversion factor is recommended by the U.S. EPA for acute criteria but a hardness dependent factor is recommended for chronic criteria. This is based upon two tests with *Daphnia* which show little relationship between the conversion factor and hardness (see below). In addition, EPA used the *Daphnia* relationship to extrapolate a value for the fathead minnow at 200 mg/l.

The data used to derive the chronic aquatic life criteria for cadmium used a pooled slope from 5 tests using *Daphnia* (N= 3) and the fathead minnow (N= 2). The chronic values for the *Daphnia*, however, varied between 0.15 and 0.44 µg/l as the hardness varied between 53 and 209 mg/l. In addition, 5 of the ten test results for *Daphnia* had to be dropped from the calculation of the acute slope because they resulted in a negative slope (i.e., toxicity increased with increasing hardness). There is therefore little justification for a hardness-related conversion factor for chronic toxicity.

Species	Food	A/T Factor	1 Hour	48 Hours	96 Hours	Time-Weighted Average*
Fathead Minnow	No	0.696	100.9**	92.9	75.6	62.9
Fathead Minnow	No	0.696	100.3**	96.2	94.1	67.3
Fathead Minnow	Brine shrimp	0.686	96.9	91.7	-	64.7
Fathead Minnow	Brine shrimp	0.686	100.4**	77.4	-	60.8
<i>Daphnia magna</i> (50 mg/l hardness)	Yeast/Trout Chow/Cereal Leaf	0.784	99.1	66.5	-	64.9
<i>D. magna</i> (50 mg/l hardness)	Yeast/Trout Chow/Cereal Leaf	0.784	92.4	98.3	-	74.8
<i>D. magna</i> (200 mg/l hardness)	Yeast/Trout Chow/Cereal Leaf	0.784	96.7	53.2	-	58.8
<i>D. magna</i> (200 mg/l hardness)	Yeast/Trout Chow/Cereal Leaf	0.784	90.8	78.3	-	66.3
Final Average Value						65.1

* - Time-weighted averages as described in Appendix K for 48 hour static tests (1.) and 96 hour static tests (2.).

** - Value over 100. Assumed to be 100.