

## **Appendix D4**

### **Toxicity Reference Value Development**

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# Appendix D4

## Toxicity Reference Value Development

### D4-1. INTRODUCTION

Toxicity assessment consists of (1) hazard evaluation, and (2) dose-response assessment. The hazard evaluation involves a comprehensive review of toxicity data for COPCs to identify the nature and severity of toxic properties, especially with respect to key receptors or similar species. Dose-response assessment would allow the prediction of the amount of chemical exposure that might result in adverse ecological effects. No dose-based toxicological criteria were available for ecological receptors at the INEEL. Therefore, it was necessary to develop appropriate toxicity reference values (TRVs) for the COPCs and receptors at INEEL. A TRV is defined as a dose for a receptor taxon (including sensitive subgroups such as taxa under regulatory protection) that is likely to be without appreciable risk of deleterious effects from chronic exposure.

### D4-2. RADIONUCLIDE TOXICITY REFERENCE VALUES

Since the establishment of the INEEL in 1949, materials (hazardous substances) have been produced, disposed of, and released at the INEEL. The list of hazardous materials includes approximately 160 radionuclides. Potential adverse effects from exposure to these radionuclides were evaluated based on the discussion presented in International Atomic Energy Agency (IAEA) technical report entitled "Effects of Ionizing Radiation on Plants and Animals at Levels implied by Current Radiation Protection Standards" (IAEA 1992). This report reviewed the available information on the effects of ionizing radiation on natural organisms determined the radiation dose and /or does rates above which there have been shown to be deleterious effects on populations of different types of terrestrial plants and animals. The findings presented in the IAEA technical report were the basis for the development of a methodology that was used to evaluate radionuclides for ecological risk assessment purposes at the INEEL (see Appendices D2 and D3).

The IAEA technical report discusses the basis for the reference values used for radionuclides and the equations (for both internal and external dose) used to determine exposure. The report states that there is little doubt that radionuclides in the environment can produce doses to certain organisms similar to or even substantially higher than doses to people living in and deriving sustenance from the same environment. Therefore, the risk of effects for natural biota (discounting variations in radiosensitivity, life span, etc.) would appear to be as high, or higher than that for humans. However, there is a basic difference in the manner that risk assessment for humans is performed. For humans, the risk assessment is directed at the individual, while other species are viewed and valued more as populations than as individuals. The IAEA (1992) technical report provides valuable information on the estimated doses to both plants and animals under current radiation protection standards. The dose estimates in this technical report (IAEA 1992) have been calculated for three different scenarios: (1) controlled releases of radionuclides to the atmosphere, (2) controlled releases of radionuclides to a freshwater aquatic system, and (3) uncontrolled releases of radionuclides from a shallow land nuclear waste repository. The last scenario is applicable for use with contaminated media at the INEEL. The IAEA (1992) determined that reproduction (including the processes from gametogenesis through to embryonic development) is likely to be the most limiting endpoint in terms of population maintenance.

For radiological protection, injury is caused by absorption of energy in living tissue from the decay of radionuclides. As in the case of chemical toxicants, the dose of radiation absorbed by any individual organism is a function of its anatomy, physiology, ecology, and behavior. Studies on the effects of radionuclides have shown that the rate of chronic exposure is more important than the total dose in assessing radiotoxicity (IAEA 1992). The TRV values for all radionuclides and all animal functional groups was 1 mGy/day, which is the chronic dose below which there does not appear to be changes observed in terrestrial animal populations (IAEA 1992). For terrestrial plants, the equivalent dose was 10 mGy/day, and this value was applied as the TRV for terrestrial plants for all radionuclides. Other available information on the effects of radionuclides on various functional groups is described below.

A chronic NOEL of 6 mGy/day was established for passerine birds based on no effect on breeding success of swallows and wrens exposed to approximately 0.7 to 6 mGy/day (IAEA 1992). The more conservative TRV of 1 mGy/day for avian groups was identified as described above in the IAEA (1992) report.

Redback vole populations (*Clethrionomys gapperi*) were unaffected at dose rates of 15 mGy/hour (IAEA 1992). Chronic exposure of pigs and donkeys to 1 mGy/day was found to be an NOEL (Garner and Barber, 1966, as cited in IAEA 1992). Chronic exposure of 4 mGy/day produced measurable declines in the number, motility, and viability of sperm in the dog, while exposure rates of < 1.2 mGy/day failed to produce sperm count changes in dogs (IAEA 1992). The more conservative TRV for mammalian groups is 1 mGy/day, which was identified for all animal functional groups (IAEA 1992).

No significant differences in sex ratios, age distributions, or life spans were observed between lizards exposed to 20 mGy/day for 5 years and control iguanid lizards (IAEA 1992). Conflicting results occurred when females of two other lizard species occupying the same enclosures became sterile, where reproduction was blocked after 1 or 2 years, and the populations later drifted towards extinction. IAEA (1992) suggests that the ovaries of the two affected species (which live longer and mature slower than the iguanid lizards) would accumulate a greater total dose before sexual maturation. As identified above, the more conservative TRV for all animal functional groups is 1 mGy/day from the IAEA (1992) report.

The IAEA (1992) concluded that invertebrates appear to be more affected by indirect than direct effects. The direct effects of radiation on terrestrial invertebrates, insects in specific, are most likely limited by responses in fertility rather than mortality.

Doses of less than 10 mGy/day were assumed to represent an NOEL for plant species (IAEA 1992). A more conservative TRV for all terrestrial plants is 10 mGy/day from the IAEA (1992) report.

### **D4-3. NONRADIONUCLIDE TOXICITY REFERENCE VALUE DEVELOPMENT**

Extrapolating contaminant toxicity to INEEL receptors from data collected on surrogate species introduces uncertainty into the risk assessment. The magnitude of the uncertainty depends upon (1) the degree of trophic level and taxonomic difference between the selected receptor species or members of the functional group and the test species, (2) the conditions under which the toxicity data were obtained, and (3) the endpoint of interest (i.e., chronic lowest-observed-adverse-effect level (LOAEL) or no-observed-adverse-effect level (NOAEL)) versus the endpoint measured (i.e., death). Uncertainties associated with extrapolation of toxicity information from laboratory to site conditions can therefore be offset by applying various adjustment factors (AFs) to the endpoint values identified in the literature.

The approach for TRV derivation described below was developed by Ludwig et al. (1993) for use at a large Superfund site, and is generally based on the EPA reference dose approach as modified by Lewis et al. (1990). It is predicated on the development and application of AFs, which are intended to explicitly account for variations and uncertainties in the data and necessary extrapolations from it. This approach offers several distinct advantages. By carefully identifying the specific types of adjustments needed in the extrapolation, it permits maximum resolution of what each adjustment is intended to achieve. Second, it emphasizes consensual, data-quality-based development of values for specific AFs rather than defaulting to arbitrary factors. Third, it clearly discriminates between “best estimates” of the values of individual factors and adjustment for overall uncertainty, including the uncertainty associated with the AFs themselves.

### **D4-3.1 Selecting QCEs**

TRV development was initiated by reviewing the available toxicological literature and relevant database for each COPC and key receptor species to identify quantified critical exposure levels (QCEs), which were exposure levels identified from the best available study. The following criteria were used for selection of QCEs:

- Experimental taxa should be as similar as possible to receptors at INEEL site(s), both physiologically and ecologically. With respect to body size, feeding and behavioral habits, anatomy, and physiology, the surrogate species should be matched as closely as possible to the species present at the INEEL.
- Test exposure route and medium should be similar to that expected for selected receptor species in the field. For most of the receptors at INEEL, the exposure media are soil and dietary items (both animal and vegetable). Dietary exposure studies are therefore the most appropriate models for extrapolation.
- Long-term (preferably lifetime) exposures should be used, as they are closest to exposure patterns occurring in the field.
- Experimental endpoints should represent relevant effects at the population level. In general, loss of a few individuals of a species is unlikely to significantly diminish the viability of the population or disrupt the community or ecosystem of which it is a part. As a result, the fundamental unit for ecological risk assessment is generally the population rather than the individual, with the exception of threatened and endangered species (EPA 1992). In general, the most appropriate endpoints for ecological risk assessment are reproduction, neurological functions, and growth and development.
- Doses within the NOAEL-LOAEL bracket should be identified. If these data are not available, the following dose levels ( in decreasing order of preference) may be used: chronic-nonlethal-adverse-effect level (AEL) > no-effect level (NEL) > frank-effect level (FEL) (including lethality). The definition of “adverse effect” requires consideration of the potential ecological significance of the responses reported. For example, elevated liver weight or enzyme induction could represent an adaptive response rather than toxic injury.
- Studies should be of high quality, defined as complete in design, with adequate numbers of subjects and dose levels, lifetime duration, explicit analysis of experimental uncertainty, clear results, and well-justified conclusions.

## D4-3.2 Adjustment Factors

Seven AFs for extrapolation from experimental studies to field exposures at INEEL were defined according to Ludwig et al. (1993):

- I - AF to account for intrataxon variability
- R - AF to account for intertaxon variability
- Q<sub>1</sub> - data quality AF reflecting the risk assessor's certainty that the COPC actually causes the critical effect in the receptor, and that it is an ecologically significant effect
- Q<sub>2</sub> - data quality AF used when extrapolating from short- to long-term exposure durations
- Q<sub>3</sub> - data quality AF used when extrapolating across endpoint types to estimate a NOAEL
- U - AF to account for any residual uncertainty in the data evaluation process and estimation of other AFs based on data quality, study design, and/or known but otherwise unaccounted for extrapolation issues.
- M - Correction of differences in metal bioavailability between QCE studies where soluble salts are administered via drinking water and INEEL exposure conditions (i.e., metal species are encountered in soil and dietary items).

Values for these AFs were set based on the quality of the selected study in particular, and of the overall database in general. Other potentially influential factors include the ecological circumstances of the receptor species, regulatory criteria and standards, background COPC levels, and protection status.

Based on a systematic review of all available information, a simple, relative scale was developed consisting of "low, medium, and high" rankings for each AF, with adjustments made on the basis of specific inherent uncertainty of variability in the particular extrapolations (Ludwig et al. 1993). To prevent needless overestimation of potential toxicity, the maximal AF product (all AFs multiplied together) was scaled to the overall extrapolation error observed in experimental studies designed specifically to determine the uncertainty in such extrapolations. Barnthouse et al. (1990) quantified the range of maximal uncertainty necessary to permit extrapolation of various kinds of toxicity data for various taxa of finfish to the population level. The types of toxicity data used included studies involving particular species of interest and other species, for acute, partial life-cycle, and full life-cycle exposures. The range of maximal uncertainty varied with the type of data used, and ranged from approximately 200-400 (Barnthouse et al. 1990). It is assumed that the degree of variability observed among fish taxa is similar to that occurring among other vertebrate taxa.

Possible values for AFs and a brief description of criteria for their selection are presented in Table D4-3-1. Values for all AFs except Q<sub>1</sub> and M were set at 1 ("low"), 2 ("medium"), and 3 ("high"), with lower values generally representing greater confidence that the QCEs correspond well with "safe" doses. The factor Q<sub>1</sub>, which expresses the degree of certainty that the experimental effect will not occur

**Table D4-3-1.** Adjustment Factor Values and criteria for their use in developing TRVs for INEEL.<sup>a</sup>

Adjustment Factor	Qualitative Ranking	Value	Criteria
I	Low	1	Variability is low
	Medium	2	Variability is moderate or average
	High	3	Variability is high, or information on variability is inadequate
R	Low	1	Test organism and receptor (or all functional group members) are in same taxonomic order and trophic category
	Medium	2	Test organism and receptor (or all functional group members) are in same trophic category but in different taxonomic orders (at least one functional group member), or for bioaccumulative COPCs, if the test organism and the receptor (or functional group) are in different trophic categories and test organism is from a higher trophic category than the receptor (or functional group)
	High	3	Test organism and receptor (or all functional group members) are in different trophic categories, and the test organism is in a lower or equivalent trophic category than the receptor (or functional group)
Q <sub>1</sub>	Low	0.1	Experimental endpoint is highly unlikely to occur in the field
	Medium	0.5	Experimental endpoint is moderately unlikely to occur in the field
	High	1	Experimental endpoint is likely to occur in the field
Q <sub>2</sub>	Low	1	Study was of chronic duration
	Medium	2	Study was of subchronic duration
	High	3	Study was of acute duration
Q <sub>3</sub>	Low	1	NOAEL
	Medium	2	LOAEL
	High	3	Adverse effect level or frank effect level
U	Low	1	High quality studies
	Medium	2	Studies of reasonable quality
	High	3	Studies with flawed design or incomplete information
M	—	0.5	Soluble metal salt administered in drinking water
	—	1	Exposure medium comparable to those at INEEL

a. Modified from Ludwig et al., 1993.

in the field or is not of ecological significance, runs on a positive scale equivalent where 0.1 represents high certainty that the effect neither occurs in the subject species nor is ecologically relevant, 0.5 represents moderate certainty that the effect does not occur or is irrelevant, and 1 represents reasonable certainty that the effect will occur in the subject species and is ecologically significant. The medium of exposure factor M is set at 1 if the medium of exposure in the QCE study is similar to field exposure media at this site (i.e., primarily food and soil ingestion). However, because a number of toxicological studies for metals used soluble salts in drinking water as a means of exposure, and both the contaminant species and exposure matrix tend to maximize metal absorption, M is set at 0.5 to conservatively represent the significantly lower bioavailability of the metal species associated with soils and dietary items in the natural environment. Thus, the minimum product of the seven AFs is 0.1, and the maximum product is 243. This AF maximum represents the extent to which data can be extrapolated across experimental protocols or among taxa.

The application of the R adjustment factor to account for intertaxon variability was as follows for use with functional groups:

- R1 Test organism and all members of the functional groups are in same trophic category and taxonomic order.
- R2 Test organism and functional group members are in same trophic category, but at least one member of the functional group is in a different taxonomic order. When the contaminant of concern is bioaccumulative, if the test organism and functional group are in different trophic categories and the test organism is from a higher trophic category than the functional group.
- R3 Test organism and functional group are in different trophic categories, and the test organism is in a lower or equivalent trophic category than the functional group.

In view of the complexity and uncertain definition of ecological exposure and responses to chemicals in the environment, it must be recognized that no single study can adequately address all possible adverse outcomes in a wild receptor population, and no single paradigm can suffice to extrapolate available toxicity data for all chemicals among all receptor groups. Although QCEs were derived from the best studies identified in the literature and all uncertainties that could be reasonably accounted for were included in the AFs used to calculate TRVs, the method used in this paper is subjective in some respects and has not been empirically validated. To offset the many uncertainties and reduce the chances that potential risks are not underestimated in the ERA, all uncertainty is assumed to be unidirectional: i.e., receptors are always assumed to be more sensitive than the experimental subjects used in the QCE studies (Ludwig et al. 1993). A consequence of this approach is that TRV values are a direct function of database quality. Thus, it is critical that the best designed and most applicable studies be identified, unwarranted extrapolation avoided, and a consensual approach be taken to the valuation of AFs.

#### **D4-4. CALCULATION OF TOXICITY REFERENCE VALUES**

Equation 1 is an algorithm that calculates the TRVs that were derived for COPCs for each functional group and species.

$$TRV = \frac{QCE}{UF} \tag{D4-1}$$

where

*QCE* = quantified critical endpoint

*UF* =  $[I] \times [R] \times [Q_1] \times [Q_2] \times [Q_3] \times [U] \times [M]$ .

And all parameters are as previously defined.

## **D4-5. SUMMARY**

An extensive search of the available databases was conducted to locate information for the contaminants of concern. Information on the toxicity of the contaminants and how they affect mammalian receptors was found for a majority of the contaminants. Toxicity information for avian receptors was more difficult to come by and when it is absent it is noted in the summary of the contaminant. Information on the fate and transport of the contaminants in the atmosphere, water, and soils was found for a majority of the contaminants. Attachment D4-1 presents a summary of the availability of TRVs and fate and transport information. The COPCs identified to date at the INEEL are listed in Table D4-1-1. The availability of TRVs, toxicity writeups, and the fate and transport writeups are identified in this table.

### **D4-5.1.1 Toxicity Results and Discussions**

Toxicity reference values for mammalian and avian receptors are presented in Tables D4-2-1 and D4-2-2 in Attachment D4-2. These tables present the final values developed from toxicity studies presented in Attachment D4-2A. The shaded values indicate those values to be used in the assessments. Several of the contaminants had multiple studies. The criteria by which each study was judged in Table D4-3-1 determined which studies would be used in the assessments. Age of the study, total adjustment factors and other criteria allowed for the best studies to be selected. Attachment D4-3 presents the toxicity writeups that generally discuss the toxicity of the contaminants.

### **D4-5.1.2 Fate and Transport Discussions**

Environmental fate properties are important because they provide information on the environmental behavior of contaminant compounds throughout various environmental media. No formal fate and transport modeling was conducted for the OU 10-04 ERA and all information was gathered from literature sources. Attachment D4-4 presents the fate and transport the contaminants identified in Table D4-1-1.

### **D4-5.1.3 Vegetation**

No articles on vegetation were reviewed to develop toxicity values. Instead, values from Suter et al. (1993), were used for 25 of the contaminants of potential concern. The 25 contaminants that have values for vegetation are listed in Table D2-5-2.

## D4-6. REFERENCES

- Barnhouse, L.W., Suter, G.W., II., and Rosen, A.E. 1990, "Risk of Toxic Contaminants to Exploited Fish Populations: Influence of Life History, Data Uncertainty and Exploitation Intensity," *Environ Toxicol Chem* **9**, 297-311.
- EPA, 1993, Wildlife Exposure Factors Handbook. Vol. 1, EPA/600/R-93/197a, U.S. Environmental Protection Agency, Office of Research and Development, December.
- Ludwig, D.F., Frantzen, K., Friello, P., Kester, J., and Banton, M.I. 1993, "An Approach to Toxicity References Value Development for Ecological Risk Assessment." Presented at the 14<sup>th</sup> Annual Meeting, Society of Environmental Toxicology and Chemistry, 14B18 November 1993, Houston, TX.
- Lewis, S.C., J.R. Lynch, and Nikiforov, A.I. (1990), "A New Approach to Deriving Community Exposure Guidelines from No-Observed-Adverse-Effect-Levels," *Regul Toxicol Pharmacol* **11**, 314-330.
- Schultz, V. and F. W. Whicker, 1982, *Radioecology: Nuclear Energy and the Environment*, CRC Press, Inc., Boca Raton, FL.
- U.S. Environmental Protection Agency (EPA), 1992 *Framework for Ecological Risk Assessment*, EPA/630/R-92/001, Risk Assessment Forum, U.S. Environmental Protection Agency, Washington, D.C.

**Appendix D4  
Attachment 1**

**Contaminant of Potential Concern  
Toxicity and Fate and Transport Information**

## **Appendix D4 Attachment 1**

### **Contaminant of Potential Concern Toxicity and Fate and Transport Information**

This attachment contains the contaminant of potential concern toxicity and fate and transport information (Table D4-1-1). An extensive search of the database was conducted to find information on the contaminants for which toxicity reference values were developed. Information on the fate and transport of the contaminants in the atmosphere, water, and soils was found for a majority of the contaminants. Information on the toxicity of the contaminants and how they affect both avian and mammalian receptors was found for a majority of the contaminants for mammalian receptors. Toxicity information for avian receptors was more difficult to come by and when it is absent it is noted in the summary of the contaminant.

A ranking system was developed to determine the quality of the summaries for the fate and transport and toxicity of the contaminants. A "3" is assigned to a summary that contains extensive information about the contaminant and the properties and receptors mentioned above. A "2" is assigned to a summary that contains good information about the contaminant but is deficient in one of the properties mentioned above or the information is not complete. A "1" is assigned to a summary that contains very little information or information that is patched together without an explanation as to how the conclusions were obtained. A "0" is assigned to a contaminant where no information was located to provide a summary of its fate and transport or its toxicity.



**Table D4-1-1. COPC toxicity and fate and transport information availability.**

CAS #	COPC	TRV <sup>a</sup>		Discussions		WAG
		Mammalian	Avian	Toxicity	Fate & Transport	
7429-90-5	Aluminum	x	x	2	3	1,3,9
7446-70-0	Aluminum chloride	x		0	0	7
21645-51-2	Aluminum hydroxide	x		0	0	7
13473-90-0	Aluminum nitrate	x		0	0	7
7784-27-2	Aluminum nitrate nonahydrate			3	0	7
10043-01-3	Aluminum sulfate		x	0	0	7
7664-41-7	Ammonia	x		0	2	7
7440-36-0	Antimony	x		2	2	1,2,3,4,9
7440-38-2	Arsenic	x	x	3	3	1,2,3,4,8,9
1332-21-4	Asbestos	x		3	2	7
7440-39-3	Barium	x		2	2	1,2,3,9
7440-41-7	Beryllium	x		2	3	9
7440-42-8	Boron	x		2	2	3
7440-43-9	Cadmium	x	x	3	3	1,2,3,4,7,9
7440-70-2	Calcium			0	0	4,5,7,9
7790-86-5	Cerium chloride	x		1	0	7
16887-00-6	Chloride	x		0	0	9
7440-47-3	Chromium (III)	x	x	3	2	1,2,3,7,9
7440-47-3	Chromium (VI)	x		3	2	1,2,3,7,9
7440-48-4	Cobalt	x	x	3	2	1,9
7440-50-8	Copper	x	x	3	3	1,2,3,4,7,9
16984-48-8	Fluoride	x	x	3	3	1,2,3,7,9
7664-39-3	Hydrofluoric acid	x		1	0	7
7439-89-6	Iron			0	0	1,9
7439-92-1	Lead	x	x	3	3	1,2,3,4,6/10, 7,8,9
7439-95-4	Magnesium	x		3	0	7,9
7783-40-6	Magnesium fluoride			0	0	7
7439-96-5	Manganese	x	x	3	2	1,7,9
7439-97-6	Mercury (Inorganic)	x	x	3	2	1,2,3,4,7,9
7439-98-7	Molybdenum	x		2	1	3
7440-02-0	Nickel	x	x	3	3	1,3,7,9
14797-55-8	Nitrate	x	x	2	0	3,7
7697-37-2	Nitric acid	x		0	0	7
1594-56-5	Nitrite			0	0	2
7440-09-7	Potassium			0	0	1,9
7447-40-7	Potassium chloride	x		0	0	7
1310-58-3	Potassium hydroxide	x		1	1	7

**Table D4-1-1. (continued).**

CAS #	COPC	TRV <sup>a</sup>		Discussions		WAG
		Mammalian	Avian	Toxicity	Fate & Transport	
7757-79-1	Potassium nitrate	x		0	0	7
7778-53-2	Potassium phosphate	x		0	0	7
7778-80-5	Potassium sulfate	x		0	0	7
7782-49-2	Selenium	x	x	3	3	1,2,3,9
7440-22-4	Silver	x		2	3	1,2,3,4,9
7440-23-5	Sodium	x		1	1	1,4,9
7647-14-5	Sodium chloride	x		0	0	7
1310-73-2	Sodium hydroxide	x		0	0	7
7631-99-4	Sodium nitrate	x	x	0	0	7
7601-54-9	Sodium phosphate	x		0	0	7
7757-82-6	Sodium sulfate			0	0	7
7440-24-6	Strontium	x		2	1	1,2,3
14808-79-8	Sulfate	x	x	1	0	1,7,9
7440-28-0	Thallium	x	x	3	3	1,2,9
7440-31-5	Tin	x		2	2	1,2
7440-61-1	Uranium	x	x	3	3	3,5,7
7440-62-2	Vanadium	x	x	3	3	1,9
7440-66-6	Zinc	x	x	3	3	1,2,9
7440-67-7	Zirconium	x		2	0	7
75-34-4	1,1-Dichloroethylene	x		3	3	7
71-55-6	1,1,1 Trichloroethane	x		2	2	7
76-13-1	1,1,2-Trichloro-1,2,2-Trifluoroethane			2	0	7
79-34-5	1,1,2,2-Tetrachloroethane	x		0	1	4
120-82-1	1,2,4-Trichlorobenzene	x		3	0	4
106-46-7	1,4-Dichlorobenzene			3	3	1
78-93-3	2-Butanone	x		2	2	4,9
108-41-8	2-Chlorotoluene	x		2	2	4
591-78-6	2-Hexanone			2	2	1
91-57-6	2-Methylnaphthalene	x		0	0	1
88-75-5	2-Nitrophenol			0	0	7
67-63-0	2-Propanol	x		2	2	7
51207-31-9	2,3,7,8,-Tetrachloro dibenzodioxin	x	x	3	2	9
105-67-9	2,4- Dimethylphenol	x		2	2	7
94-75-7	2,4-Dichlorophenoxyacetic acid	x		2	3	7
121-14-2	2,4-Dinitrotoluene	x		3	3	7
106-47-8	4-Chloroaniline	x		2	2	2,3
106-44-5	4-Methylphenol	x		3	3	7

**Table D4-1-1.** (continued).

CAS #	COPC	TRV <sup>a</sup>		Discussions		WAG
		Mammalian	Avian	Toxicity	Fate & Transport	
59-50-7	4-Chloro-3-methylphenol (CMP)	x		1	1	7
83-32-9	Acenaphthene	x		2	2	1,4,7
67-64-1	Acetone	x		2	2	2,3,4,7
75-05-8	Acetonitrile	x		3	3	2
107-13-1	Acrylonitrile	x		3	2	2
120-12-7	Anthracene	x		2	2	4
71-43-2	Benzene	x		2	2	7
8032-32-4	Benzine			1	0	7
56-55-3	Benzo(a)anthracene	x		3	2	1,4
50-32-8	Benzo(a)pyrene	x		3	2	1,3,4
205-99-2	Benzo(b)fluoranthene (BbF)	x		2	2	1,2,3,4
207-08-9	Benzo(k)fluoranthene			0	0	7
191-24-2	Benzo(g,h,i)perylene			0	0	1
71-36-3	Butyl alcohol	x		2	0	7
85-68-7	Butylbenzylphthalate (BBP)	x		2	3	9
75-15-0	Carbon disulfide	x		2	3	5
56-23-5	Carbon tetrachloride	x		3	2	7
67-66-3	Chloroform	x		3	3	7
74-8-7-3	Chloromethane			0	0	1
218-01-9	Chrysene	x		2	2	1,2,4
57-12-5	Cyanide	x	x	2	3	1,3,7,9
112-31-2	Decanal			0	0	3
132-64-9	Dibenzofuran			0	2	2
75-71-8	Dichlorodifluoromethane			0	0	1
117-81-7	Di-2-ethylhexyl-phthalate (DEHP)	x		2	3	1,3
84-66-2	Diethyl phthalate	x		3	3	3
131-11-3	Dimethyl phthalate			0	0	4
84-74-2	Di-n-butylphthalate	x		2	3	4
117-84-0	Di-n-octylphthalate	x		1	1	4
64-17-5	Ethanol (Ethyl alcohol)	x		3	0	7
100-41-4	Ethylbenzene	x		2	2	1,4
206-44-0	Fluoranthene	x		2	2	4
86-73-7	Fluorene	x		2	2	4
50-00-0	Formaldehyde	x		2	0	7
302-01-2	Hydrazine	x		3	1	7,9
78-59-1	Isophorone			2	2	5
193-39-5	Indeno(1,2,3)pyrene			0	2	1

**Table D4-1-1.** (continued).

CAS #	COPC	TRV <sup>a</sup>		Discussions		WAG
		Mammalian	Avian	Toxicity	Fate & Transport	
7439-97-6	Mercury (organic)	x	x	3	2	1,2,3,4,7,9
67-56-1	Methanol (methyl alcohol)	x		2	0	7
108-10-1	Methyl isobutyl ketone	x		2	0	7
75-09-2	Methylene chloride	x		2	2	4,7
103-65-1	n-Propylbenzene	x		0	0	7
91-20-3	Naphthalene	x		2	3	1,4
78-48-8	Orthophosphate			0	0	2
11097-69-1	PCBs - Aroclor 1254	x	x	3	3	1,4
11096-82-5	PCBs - Aroclor 1260	x		3	3	1
85-01-8	Phenanthrene			2	2	1
108-95-2	Phenol	x		3	3	7
107-12-0	Propionitrile			0	0	1
129-00-0	Pyrene	x		2	2	4
143-33-9	Sodium cyanide	x		0	0	7
18496-25-8	Sulfide			0	0	1,2
7664-93-9	Sulfuric acid	x		2	0	4,7
26140-60-3	Terphenyl	x		2	0	7
127-18-4	Tetrachloroethylene	x		2	2	7
109-99-9	Tetrahydrofuran	x		0	0	1
108-88-3	Toluene	x		2	3	4,7
	Total petroleum hydrocarbon			1	0	1,4,6/10
126-73-8	Tributyl phosphate	x		1	0	7
79-01-6	Trichloroethylene (Trichloroethene)	x		2	3	4,7
15625-89-5	Trimethylpropane-triester	x		1	0	7
108-05-4	Vinyl acetate			0	0	1,5
1330-20-7	Xylene	x		2	3	1

a. TRV available

0 = no information available

1 = very little information available

2 = good information available

3 = excellent information available.

**Appendix D4  
Attachment 2**

**Toxicity Reference Values for  
Mammalian and Avian Functional Group**

## **Appendix D4 Attachment 2**

### **Toxicity Reference Values for Mammalian and Avian Functional Group**

This attachment contains the toxicity reference values for the mammalian and avian functional group. Table D4-2-1 is a compilation of the toxicity reference values for mammalian functional groups and Table D4-2-2 is a compilation of the toxicity reference values for the avian functional groups. Attachment 2A that follows these tables is the basis for how each contaminant of potential concern was assigned a toxicity reference value for each functional group. The explanation for how each toxicity reference value was obtained for the contaminant of potential concern is discussed at the beginning of Appendix D4. Each sheet is a review of an article about the contaminant of potential concern. All the studies that were reviewed are summarized in these sheets. The toxicity reference values that were used in Tables D4-2-1 and D4-2-2 were pulled from these sheets.

**Table D4-2-1. Compilation of toxicity reference values (TRVs in mg/kg-day) for mammalian functional groups.**

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
1,1-Dichloroethylene (Rat - NOAEL)	7.11	7.11	7.11	7.11	7.11	7.11	7.11	7.11	10.7	10.7
1,1-Dichloroethylene (Dog - NOAEL)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	3.1	6.3
1,1-Dichloroethylene <sup>a</sup> (Rat - NOAEL)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3.8	3.8
1,1,1 Trichloroethane (Mouse - NOAEL)	333	333	333	333	333	333	333	333	500	500
1,1,2,2-Tetrachloroethane (Mouse - FEL)	7.89	7.89	7.89	7.89	7.89	7.89	7.89	7.89	11.8	11.8
1,2,4-Trichlorobenzene (Rat - NOAEL)	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.56	0.83	0.83
2-Butanone (Rat - NOAEL)	295.2	295.2	295.2	295.2	295.2	295.2	295.2	295.2	442.8	442.8
2-Chlorotoluene (Rat - NOAEL)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	5.0	5.0
2-Methylnaphthalene <sup>b</sup> (used values for benzo(a)pyrene)	92.6	92.6	92.6	92.6	92.6	92.6	92.6	92.6	139	139
2-Propanol (Mouse and Rat - NOAEL)	217	217	217	217	217	217	217	217	325	325
2,3,7,8-Tetrachloro dibenzodioxin (Rat - NOAEL)	3E-7	3E-7	3E-7	3E-7	3E-7	3E-7	3E-7	3E-7	5E-7	5E-7
2,4-Dichlorophenoxyacetic acid (Rat and Mouse - NOAEL)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.33	0.5	0.5
2,4-Dimethylphenol (Mouse - NOAEL)	17	17	17	17	17	17	17	17	25	25
2,4-Dinitrotoluene (Dog - NOAEL)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.05	0.10
4-Chloroaniline (Rat and Mouse - LOAEL)	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.78	0.78
4-Methylphenol (p-Cresol) (Rat - NOAEL)	4.2	4.2	4.2	4.2	4.2	4.2	4.2	4.2	6.3	6.3
4-Chloro-3-methylphenol (CMP) (Rat - NOAEL)	5.6	5.6	5.6	5.6	5.6	5.6	5.6	5.6	8.3	8.3

**Table D4-2-1. (continued).**

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
Acenaphthene (Mouse - NOAEL)	14.6	14.6	14.6	14.6	14.6	14.6	14.6	14.6	21.9	21.9
Acetone (Mouse and Rat - NOAEL)	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	13	13
Acetonitrile (Hamsters - LOAEL)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	2.1	2.1
Acetonitrile (Rat - NOAEL)	5.3	5.3	5.3	5.3	5.3	5.3	5.3	5.3	7.9	7.9
Acetonitrile <sup>a</sup> (Rat and Mouse - NOAEL)	6.43	6.43	6.43	6.43	6.43	6.43	6.43	6.43	9.65	0.65
Acrylonitrile (Mouse - LOAEL)	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.63	0.63
Acrylonitrile (Rat - NOAEL)	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.14	0.14
Aluminum (Bovine - NOAEL)	2.55	2.55	2.55	2.55	1.70	1.70	1.70	1.70	1.70	1.70
Aluminum (Rabbit - NOAEL)	0.016	0.016	0.016	0.016	0.011	0.011	0.011	0.011	0.011	0.011
Aluminum (Rat - LOAEL)	2.18	2.18	2.18	2.18	2.18	2.18	2.18	2.18	3.26	3.26
Aluminum (Rat - AEL)	3.2	3.2	3.2	3.2	3.2	3.2	3.2	3.2	4.8	4.8
Aluminum chloride (Bovine - NOAEL)	4.82	4.82	4.82	4.82	3.21	3.21	3.21	3.21	3.21	3.21
Aluminum hydroxide (Rat - AEL)	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	18.5	18.5
Aluminum nitrate (Rabbit - NOAEL)	0.11	0.11	0.11	0.11	0.07	0.07	0.07	0.07	0.07	0.07
Aluminum nitrate (Rat - LOAEL)	15	15	15	15	15	15	15	15	23	23
Ammonia (Rat - LD <sub>50</sub> )	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	2.2	2.2
Anthracene (Mouse - NOAEL)	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	62.5	62.5
Antimony (Mouse - LOAEL)	0.417	0.417	0.417	0.417	0.417	0.417	0.417	0.417	0.625	0.625
Arsenic (Dog - NOAEL)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.16	0.32
Arsenic (Mouse - LOAEL)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.16	0.16
Arsenic (Rat - NOAEL)	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.39	0.39
Arsenic (Sheep - NOAEL)	0.06	0.06	0.06	0.06	0.04	0.04	0.04	0.04	0.04	0.04
Asbestos (Mouse - NOAEL)	67	67	67	67	67	67	67	67	100	100

**Table D4-2-1.** (continued).

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
Asbestos (Rat - LOAEL)	6,578	6,578	6,588	6,578	6,578	6,578	6,578	6,578	9,867	9,867
Barium (Rat - NOAEL)	0.68	0.68	0.68	0.68	0.68	0.68	0.68	0.68	1.0	1.0
Barium (Dog - FEL-1)	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.36	0.73
Barium Chloride (Rat - NOAEL)	5.81	5.81	5.81	5.81	5.81	5.81	5.81	5.81	8.71	8.71
Benzene (Mouse - LOAEL)	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	5.49	5.49
Benzene (Mouse and Rat - FEL)	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	1.0	1.0
Benzine <sup>c</sup> (Mouse - LD <sub>50</sub> )	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.25	0.25
Benzo(a)anthracene (Mouse - FEL)	9.3	9.3	9.3	9.3	9.3	9.3	9.3	9.3	14	14
Benzo(a)pyrene (Mouse - FEL)	92.6	92.6	92.6	92.6	92.6	92.6	92.6	92.6	139	139
Benzo(b)fluoranthene (BbF) <sup>b</sup> (Mouse - LOAEL)	92.6	92.6	92.6	92.6	92.6	92.6	92.6	92.6	139	139
Beryllium (Rat - NOAEL)	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.33	0.33
Bis(tri-n-butyltin)oxide <sup>d</sup> (Mouse - LD <sub>50</sub> )	0.69	0.69	0.69	0.69	0.69	0.69	0.69	0.69	1.0	1.0
Bis(tri-n-butyltin)oxide (Mouse - NOAEL)	7.8	7.8	7.8	7.8	7.8	7.8	7.8	7.8	11.7	11.7
Boron (Dog - NOAEL)	1.46	1.46	1.46	1.46	1.46	1.46	1.46	1.46	2.19	4.37
Boron (Rat - NOAEL)	2.92	2.92	2.92	2.92	2.92	2.92	2.92	2.92	4.38	4.38
Butyl alcohol (n-Butanol) (Rat - NOAEL)	41.7	41.7	41.7	41.7	41.7	41.7	41.7	41.7	62.5	62.5
Butylbenzylphthalate (BBP) (Rat - NOAEL)	4.42	4.42	4.42	4.42	4.42	4.42	4.42	4.42	6.63	6.63
Cadmium (Rat - LOAEL)	8E-4	8E-4	8E-4	8E-4	8E-4	8E-4	8E-4	8E-4	1E-3	1E-3
Carbon disulfide <sup>e</sup> (Rabbit and Rat - NOAEL)	0.46	0.46	0.46	0.46	0.31	0.31	0.31	0.31	0.31	0.31
Carbon disulfide <sup>e</sup> (Rabbit - NOAEL)	1.0	1.0	1.0	1.0	0.69	0.69	0.69	0.69	0.69	0.69
Carbon tetrachloride (Rat - NOAEL)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.09	0.09

**Table D4-2-1. (continued).**

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
Carbon tetrachloride (Rat - NOAEL)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	5.0	5.0
Cerium chloride (Rat - FEL)	8.68	8.68	8.68	8.68	8.68	8.68	8.68	8.68	13.03	13.03
Chloroform (Rat - NOAEL)	12.5	12.5	12.5	12.5	12.5	12.5	12.5	12.5	18.8	18.8
Chloroform (Dog - NOAEL)	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.08	1.61	3.23
Chloroform (Rabbit - LOAEL)	0.63	0.63	0.63	0.63	0.42	0.42	0.42	0.42	0.42	0.42
Chloroform (Rat - NOAEL)	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	1.3	1.3
Chromium (III) (Rat - NOAEL)	250	250	250	250	250	250	250	250	375	375
Chromium (VI) (Dog - NOAEL)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.08	0.15
Chromium (VI) (Mouse - FEL)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	4.9	4.9
Chrysene <sup>bs</sup> (benzo(a)pyrene values used)	92.6	92.6	92.6	92.6	92.6	92.6	92.6	92.6	139	139
Cobalt (Dog - NOAEL)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	2.1	2.1
Cobalt (Rat - NOAEL)	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.21	0.21
Copper (Mink - NOAEL)	0.65	0.65	0.65	0.65	0.65	0.65	0.65	1.95	0.65	0.65
Copper (Rat - NOAEL)	1.8	1.8	1.8	1.8	1.8	1.8	1.8	1.8	2.8	2.8
Cyanide (Pig - LOAEL)	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.26	0.39	0.39
Cyanide (Rat - NOAEL)	1.80	1.80	1.80	1.80	1.80	1.80	1.80	1.80	2.70	2.70
Diethyl phthalate (Rat - NOAEL)	62.5	62.5	62.5	62.5	62.5	62.5	62.5	62.5	93.8	93.8
Di-2-ethylhexyl-phthalate (DEHP) (Guinea Pig - LOAEL)	0.79	0.79	0.79	0.79	0.79	0.79	0.79	0.79	1.2	1.2
Di-n-butylphthalate (Rat - NOAEL)	4.63	4.63	4.63	4.63	4.63	4.63	4.63	4.63	6.94	6.94
Di-n-octylphthalate (Rat - LOAEL)	14.5	14.5	14.5	14.5	14.5	14.5	14.5	14.5	21.8	21.8
Ethanol (Rat - LOAEL)	2.66	2.66	2.66	2.66	2.66	2.66	2.66	2.66	3.99	3.99
Ethanol (Rat - AEL)	250	250	250	250	250	250	250	250	375	375
Ethylbenzene (Rat - LOAEL)	17.0	17.0	17.0	17.0	17.0	17.0	17.0	17.0	25.5	25.5

**Table D4-2-1. (continued).**

Chemical	TRV for											
	M121	M122	M122A	M123	M210	M210A	M222	M322	M422	M422A	M422A	M422A
Fluoranthene (Mouse - NOAEL)	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	15.6	15.6	15.6	15.6
Fluorene (Mouse - LOAEL)	10.4	10.4	10.4	10.4	10.4	10.4	10.4	10.4	15.6	15.6	15.6	15.6
Fluoride (Mink - NOAEL)	10.5	10.5	10.5	10.5	10.5	10.5	10.5	31.4	10.5	10.5	10.5	10.5
Formaldehyde (Beagle Dog - NOAEL)	0.78	0.78	0.78	0.78	0.78	0.78	0.78	0.78	1.2	2.4	2.4	2.4
Formaldehyde (Rat - NOAEL)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	7.5	7.5	7.5	7.5
Hexachlorobenzene (Rat - NOAEL)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	10	10	10	10
Hexachlorobenzene (Mink - NOAEL)	0.33	0.33	0.33	0.33	0.33	0.33	0.33	1.0	0.33	0.33	0.33	0.33
Hexachlorocyclohexane (Rat - NOAEL)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	5.0	5.0	5.0	5.0
Hydrazine (Mouse - NOAEL)	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	1.4	1.4	1.4	1.4
Hydrofluoric acid <sup>a</sup> (Mouse - FEL)	1.62	1.62	1.62	1.62	1.62	1.62	1.62	1.62	2.44	2.44	2.44	2.44
Hydrofluoric acid <sup>a</sup> (Rat - AEL)	4.35	4.35	4.35	4.35	4.35	4.35	4.35	4.35	6.53	6.53	6.53	6.53
Lead (Bovine - LD <sub>50</sub> )	0.038	0.038	0.038	0.038	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025
Lead (Beagle Dog - NOAEL)	0.81	0.81	0.81	0.81	0.81	0.81	0.81	0.81	1.6	3.3	3.3	3.3
Lead (Dog - FEL)	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.009	0.018	0.018	0.018
Lead (Rat - NOAEL)	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.12	0.18	0.18	0.18	0.18
Lead (Rat - NOAEL)	2.7	2.7	2.7	2.7	2.7	2.7	2.7	2.7	4.0	4.0	4.0	4.0
Magnesium (Sheep - NOAEL)	4.3	4.3	4.3	4.3	2.9	2.9	2.9	2.9	2.9	2.9	2.9	2.9
Manganese (Rat - NOAEL)	29	29	29	29	29	29	29	29	44	44	44	44
Mercury (Inorganic) (Mouse - NOAEL)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.17	0.17	0.17	0.17
Mercury (Inorganic) (Swine - NOAEL)	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.021	0.031	0.031	0.031	0.031
Mercury (Organic) (Bovine - NOAEL)	0.006	0.006	0.006	0.006	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004

Table D4-2-1. (continued).

Chemical	TRV for M121	TRV for M122	TRV for M122A	TRV for M123	TRV for M210	TRV for M210A	TRV for M222	TRV for M322	TRV for M422	TRV for M422A
Mercury (Organic) (Mink - NOAEL)	0.019	0.019	0.019	0.019	0.013	0.013	0.013	0.013	0.013	0.013
Mercury (Organic) (Mouse - NOAEL)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.04
Mercury (Organic) (Swine - NOAEL)	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0021	0.0031	0.0031
Mercury (Organic) (Rat - NOAEL)	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.013	0.013
Mercury (Organic) (Rat - NOAEL)	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.0083	0.013	0.013
Mercury (Organic) (Deer - LD <sub>50</sub> )	0.11	0.11	0.11	0.11	0.07	0.07	0.07	0.07	0.07	0.07
Mercury (Organic) (Cat - NOAEL)	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.005	0.002	0.003
Methanol (Rat - NOAEL)	170	170	170	170	170	170	170	170	250	250
Methyl isobutyl ketone (Rat - NOAEL)	21	21	21	21	21	21	21	21	31	31
Methylene chloride (Rat - NOAEL)	1.95	1.95	1.95	1.95	1.95	1.95	1.95	1.95	2.93	2.93
Molybdenum (Guinea pig - LOAEL)	3.3	3.3	3.3	3.3	3.3	3.3	3.3	3.3	5.0	5.0
Molybdenum (Rat - LOAEL)	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.38	0.38
Molybdenum (Rat - LOAEL)	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.06	0.08	0.08
Molybdenum (Rat - LOAEL)	0.83	0.83	0.83	0.83	0.83	0.83	0.83	0.83	1.3	1.3
n-Propylbenzene <sup>e</sup> (benzene values used)	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	5.49	5.49
Naphthalene (Mouse - NOAEL)	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.44	0.66	0.66
Nickel (Bovine - NOAEL)	0.11	0.11	0.11	0.11	0.08	0.08	0.08	0.08	0.08	0.08
Nickel (Dog - NOAEL)	19.0	19.0	19.0	19.0	19.0	19.0	19.0	19.0	28.5	28.5
Nickel (Rat - NOAEL)	6.7	6.7	6.7	6.7	6.7	6.7	6.7	6.7	10	10
Nitrate (Rabbit - AEL)	83.21	83.21	83.21	83.21	55.47	55.47	55.47	55.47	55.47	55.47

**Table D4-2-1. (continued).**

Chemical	TRV for												
	M121	M122	M122A	M123	M210	M210A	M222	M322	M422	M422A			
Nitrate (Guinea pig - NOAEL)	17	17	17	17	17	17	17	17	25	25			
Nitric acid <sup>a</sup> (Rat - NOAEL)	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.5	1.5			
PCBs - Aroclor 1254 (Mouse - FEL)	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.025	0.038	0.038			
PCBs - Aroclor 1254 (Mink - NOAEL)	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.137	0.046	0.046			
PCBs - Aroclor 1254 (Rat - NOAEL)	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.16	0.16			
PCBs - Aroclor 1254 (Mink - NOAEL)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.015	0.005	0.005			
PCBs - Aroclor 1260 (Rat - NOAEL)	2.5	2.5	2.5	2.5	2.5	2.5	2.5	2.5	3.7	3.7			
Phenol (Rat - NOAEL)	13	13	13	13	13	13	13	13	20	20			
Potassium chloride (Mouse - LD <sub>50</sub> )	6.2	6.2	6.2	6.2	6.2	6.2	6.2	6.2	9.3	9.3			
Potassium hydroxide (Rat - LD <sub>50</sub> )	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.51	0.76	0.76			
Potassium nitrate (Rat - AEL)	0.72	0.72	0.72	0.72	0.72	0.72	0.72	0.72	1.1	1.1			
Potassium nitrate (Guinea pig - NOAEL)	17	17	17	17	17	17	17	17	25	25			
Potassium nitrate (Rabbit - AEL)	271.0	271.0	271.0	271.0	180.7	180.7	180.7	180.7	180.7	180.7			
Potassium nitrate (Horse - AEL)	6.17	6.17	6.17	6.17	4.12	4.12	4.12	4.12	4.12	4.12			
Potassium nitrate (Sheep - FEL)	6.2	6.2	6.2	6.2	4.1	4.1	4.1	4.1	4.1	4.1			
Potassium phosphate (Rat - LD <sub>50</sub> )	5.8	5.8	5.8	5.8	5.8	5.8	5.8	5.8	8.6	8.6			
Potassium sulfate (Rat - LD <sub>50</sub> )	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	15.0	15.0			
Pyrene (Mouse - NOAEL)	13	13	13	13	13	13	13	13	19	19			
Selenium (Mouse - FEL)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06			
Selenium (Rat - NOAEL)	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.13	0.20	0.20			

**Table D4-2-1.** (continued).

Chemical	TRV for											
	M121	M122	M122A	M123	M210	M210A	M222	M322	M422	M422A	M422A	M422A
Selenium (Sheep - FEL)	0.02	0.02	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Silver (Mouse - FEL)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	1.3	1.3	1.3
Silver (Swine - NOAEL)	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3	17.0	17.0	17.0
Silver (Rat - NOAEL)	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	10.8	16.3	16.3	16.3
Sodium chloride (Rat - FEL)	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	2.88	4.33	4.33	4.33
Sodium hydroxide (Rabbit - LD <sub>50</sub> )	3.1	3.1	3.1	3.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Sodium phosphate (Mouse - LD <sub>50</sub> )	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	16.1	24.2	24.2	24.2
Strontium (Rat - NOAEL)	32	32	32	32	32	32	32	32	32	48	48	48
Sulfate (Rat - LD <sub>50</sub> )	5.32	5.32	5.32	5.32	5.32	5.32	5.32	5.32	5.32	7.98	7.98	7.98
Sulfuric acid* (Guinea pig - LOAEL)	0.11	0.07	0.07	0.11	0.07	0.07	0.07	0.07	0.07	0.11	0.11	0.11
Terphenyl (Rat - LOAEL)	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	2.3	3.5	3.5	3.5
Tetrachloroethylene (Mouse - NOAEL)	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.8	1.8	1.8
Tetrahydrofuran <sup>†</sup> (2,3,7,8-Tetrachloro dibenzodioxin values used)	3E-7	5E-7	5E-7	5E-7								
Thallium (Rat - LOAEL)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.12	0.12	0.12
Thallium (Rat - LOAEL)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06	0.06
Tin (Dog - LD <sub>100</sub> )	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.22	0.33	0.33	0.33
Tin (Rat - NOAEL)	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.15	1.72	1.72	1.72
Toluene (Rat - NOAEL)	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	18.6	27.9	27.9	27.9
Toluene (Mouse - LOAEL)	22	22	22	22	22	22	22	22	22	33	33	33
Total Petroleum Hydrocarbon <sup>‡</sup> (benzene values used)	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	3.66	5.49	5.49	5.49
Tributyl phosphate (Rat - LD <sub>50</sub> )	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	12.3	18.5	18.5	18.5
Trichloroethylene (Mouse - FEL)	139	139	139	139	139	139	139	139	139	208	208	208

**Table D4-2-1. (continued).**

Chemical	TRV for											
	M121	M122	M122A	M123	M210	M210A	M222	M322	M422	M422A	M422A	M422A
Trichloroethylene (Rat - NOAEL)	8.3	8.3	8.3	8.3	8.3	8.3	8.3	8.3	13	13	13	13
Trichloroethylene (Rabbit - LD <sub>50</sub> )	45.3	45.3	45.3	45.3	30.2	30.2	30.2	30.2	30.2	30.2	30.2	30.2
Trichloroethylene (Dog - LD <sub>50</sub> )	23.4	23.4	23.4	23.4	23.4	23.4	23.4	35.1	35.1	35.1	70.1	70.1
Trichloroethylene (Cat - LD <sub>50</sub> )	36.2	36.2	36.2	36.2	36.2	36.2	36.2	108.6	36.2	36.2	54.3	54.3
Trimethylpropane-triester (Rat - LD <sub>50</sub> )	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.06	0.06	0.06	0.06
Uranium (Mouse - NOAEL)	0.512	0.512	0.512	0.512	0.512	0.512	0.512	0.512	0.768	0.768	0.768	0.768
Uranium (Rabbit - LOAEL)	0.13	0.13	0.13	0.13	0.09	0.09	0.09	0.09	0.09	0.09	0.09	0.09
Vanadium (Bovine - NOAEL)	0.47	0.47	0.47	0.47	0.31	0.31	0.31	0.31	0.31	0.31	0.31	0.31
Vanadium (Mouse - NOAEL)	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.46	0.68	0.68	0.68	0.68
Vanadium (Rat - LOAEL)	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.26	0.26	0.26	0.26
Xylene (Mouse - NOAEL)	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.086	0.129	0.129	0.129	0.129
Xylene (Rat - NOAEL)	20.8	20.8	20.8	20.8	20.8	20.8	20.8	20.8	31.3	31.3	31.3	31.3
Zinc (Ferret - NOAEL)	7.89	7.89	7.89	7.89	7.89	7.89	7.89	23.7	7.89	7.89	7.89	7.89
Zinc (Rat - NOAEL)	14	14	14	14	14	14	14	14	21	21	21	21
Zirconium (Mouse - NOAEL)	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.58	0.87	0.87	0.87	0.87
Zirconium (Rat - NOAEL)	198.8	198.8	198.8	198.8	198.8	198.8	198.8	198.8	298.1	298.1	298.1	298.1

a. Route of exposure is inhalation, should not be used for oral intake. See Appendix D4 Attachment 2A.

b. Identified as a COPC. No TRV development performed. Values for benz(a)pyrene used.

c. Route of exposure through intravenous injection, should not be used for oral intake. See Appendix D4 Attachment 2A.

d. Route of exposure through intraperitoneal injection. See Appendix D4 Attachment 2A.

e. No data was located specifically for n-propylbenzene, values for benzene used and considered conservative.

f. Values for 2,3,7,8 - Tetrachlorodibenzodioxin used.

g. Dermal exposure, should not be used for oral intake. See Appendix D4 Attachment 2A.

No data located for:  
 4-nitrophenol  
 Benzo(g,h,i)perylene  
 Benzoic acid  
 Pentachlorophenol  
 Phenanthrene  
 Sulfide  
 Trans-1,3-dichloropropene

**Table D4-2-2.** Compilation of toxicity reference values (TRVs in mg/kg-day) for avian functional groups.

Chemical	TRV for AV121	TRV for AV122	TRV for AV132	TRV for AV142	TRV for AV143	TRV for AV210	TRV for AV210A	TRV for AV221	TRV for AV222	TRV for AV222A	TRV for AV232
2,3,7,8,- Tetrachloro dibenzodioxin <sup>a</sup> (Pheasant - NOAEL)	75	75	75	75	75	75	75	75	75	75	75
Aluminum (Chicken - NOAEL)	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60	7.60
Aluminum (Turkey - NOAEL)	292	292	292	292	292	292	292	292	292	292	292
Aluminum hydroxide (Chicken - NOAEL)	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5	13.5
Aluminum sulfate (Turkey - NOAEL)	0.046	0.046	0.046	0.046	0.046	0.069	0.069	0.069	0.069	0.069	0.069
Arsenic (Brown-headed cowbird -Mortality)	0.64	0.64	0.64	1.29	1.29	0.43	0.43	0.43	0.43	0.43	0.43
Arsenic (Mallard - NOAEL)	0.24	0.24	0.24	0.48	0.48	0.16	0.16	0.16	0.16	0.16	0.16
Arsenic (Mallard - LD <sub>50</sub> )	150	150	150	300	300	100	100	100	100	100	100
Boron (Mallard - NOAEL)	0.04	0.04	0.04	0.07	0.07	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium (Black Duck - LOAEL)	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27	0.27
Cadmium (Chicken - LOAEL)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4	1.4
Chromium-III (Chicken - NOAEL)	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213
Cobalt (Chicken - LOAEL)	27.89	27.89	27.89	27.89	27.89	27.89	27.89	27.89	27.89	27.89	27.89
Copper (Chicken - NOAEL)	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61	4.61
Copper (Chicken - NOAEL)	0.04	0.04	0.04	0.04	0.04	0.06	0.06	0.06	0.06	0.06	0.06
Cyanide (European Starling - LD <sub>50</sub> )	0.009	0.009	0.009	0.018	0.018	0.006	0.006	0.006	0.006	0.006	0.006
Cyanide (Mallard - LD <sub>50</sub> )	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.3
Fluoride (Screech Owl - NOAEL)	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.48
Lead (Chicken - NOAEL)	0.03	0.03	0.03	0.03	0.03	0.04	0.04	0.04	0.04	0.04	0.04
Lead (European Starling - LOAEL)	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0
Manganese (Chicken - NOAEL)	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0	70.0

**Table D4-2-2. (continued).**

Chemical	TRV for AV121	TRV for AV122	TRV for AV132	TRV for AV142	TRV for AV143	TRV for AV210	TRV for AV210A	TRV for AV221	TRV for AV222	TRV for AV222A	TRV for AV232
Manganese	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3	21.3
(Japanese Quail - NOAEL)											
Mercury (Inorganic)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
(Japanese quail - NOAEL)											
Mercury (Inorganic)	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02	2.02
(Chicken - NOAEL)											
Mercury (Organic)	0.0047	0.0047	0.0047	0.0094	0.0094	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031
(American black duck - AEL)											
Mercury (Organic)	0.012	0.012	0.012	0.024	0.024	0.008	0.008	0.008	0.008	0.008	0.008
(Mallard - LOAEL)											
Mercury (Organic)	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.004
(Pheasant - AEL)											
Mercury (Organic)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
(Pheasant - LOAEL)											
Nickel (Chicken - NOAEL)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1	2.1
Nickel (Mallard - NOAEL)	8.75	8.75	8.75	17.5	17.5	5.83	5.83	5.83	5.83	5.83	5.83
Nickel (Mallard - NOAEL)	50	50	50	100	100	33	33	33	33	33	33
Nitrate (Turkey - FEL)	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9	8.9
PCBs (1254)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
(Pheasant - LOAEL)											
Selenium (Black Crowned Night Heron - LOAEL)	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
Selenium (Chicken - NOAEL)	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033
Selenium (Mallard - NOAEL)	0.13	0.13	0.13	0.25	0.25	0.08	0.08	0.08	0.08	0.08	0.08
Sodium nitrate (Juvenile turkeys - LOAEL)	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3	18.3
Sulfate (Turkey - NOAEL)	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64	8.64
Thallium (Quail - FEL)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Uranium	20	20	20	40	40	13	13	13	13	13	13
(Black Duck - NOAEL)											
Vanadium (Chicken - NOAEL)	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Vanadium (Mallard - NOAEL)	0.13	0.13	0.13	0.25	0.25	0.08	0.08	0.08	0.08	0.08	0.08
Zinc (Chicken - LOAEL)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0	2.0
Zinc (Mallard - LOAEL)	12.9	12.9	12.9	25.9	25.9	8.63	8.63	8.63	8.63	8.63	8.63

**Table D4-2-2. (continued).**

Chemical	TRV for AV233	TRV for AV241	TRV for AV242	TRV for AV310	TRV for AV322	TRV for AV333	TRV for AV342	TRV for AV422	TRV for AV432	TRV for AV433	TRV for AV442
2,3,7,8,-Tetrachloro dibenzodioxin <sup>a</sup> (Pheasant - NOAEL)											
Aluminum (Chicken - NOAEL)	75	75	75	75	75	75	75	110	110	110	110
Aluminum (Turkey - NOAEL)	7.60	7.60	7.60	7.60	7.60	7.60	7.60	11.39	11.39	11.39	11.39
Aluminum hydroxide (Chicken - NOAEL)	292	292	292	292	292	292	292	438	438	438	438
Aluminum sulfate (Turkey - NOAEL)	13.5	13.5	13.5	13.5	13.5	13.5	13.5	20.3	20.3	20.3	20.3
Arsenic (Brown-headed cowbird - Mortality)	0.069	0.069	0.069	0.046	0.046	0.046	0.046	0.046	0.046	0.046	0.046
Arsenic (Mallard - NOAEL)	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43	0.43
Arsenic (Mallard - LD <sub>50</sub> )	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.16
Boron (Mallard - NOAEL)	100	100	100	100	100	100	100	100	100	100	100
Cadmium (Black Duck - LOAEL)	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
Cadmium (Chicken - LOAEL)	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.27	0.27	0.27	0.27
Chromium-III (Chicken - NOAEL)	1.4	1.4	1.4	1.4	1.4	1.4	1.4	2.0	2.0	2.0	2.0
Cobalt (Chicken - LOAEL)	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.319	0.319	0.319	0.319
Copper (Chicken - NOAEL)	27.89	27.89	27.89	27.89	27.89	27.89	27.89	41.92	41.92	41.92	41.92
Copper (Chicken - NOAEL)	4.61	4.61	4.61	4.61	4.61	4.61	4.61	6.91	6.91	6.91	6.91
Cyanide(European Starling - LD <sub>50</sub> )	0.06	0.06	0.06	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Cyanide (Mallard - LD <sub>50</sub> )	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006	0.006
Fluoride (Screech Owl - NOAEL)	1.3	1.3	1.3	2.0	2.0	2.0	2.0	1.3	1.3	1.3	1.3

**Table D4-2-2. (continued).**

Chemical	TRV for AV233	TRV for AV241	TRV for AV242	TRV for AV310	TRV for AV322	TRV for AV333	TRV for AV342	TRV for AV422	TRV for AV432	TRV for AV433	TRV for AV442
Lead (Chicken - NOAEL)	0.48	0.48	0.48	0.48	0.48	0.48	0.48	0.72	0.72	0.72	0.72
Lead (European Starling - LOAEL)	0.04	0.04	0.04	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Manganese (Chicken - NOAEL)	70.0	70.0	70.0	70.0	70.0	70.0	70.0	105	105	105	105
Manganese (Japanese Quail - NOAEL)	21.3	21.3	21.3	21.3	21.3	21.3	21.3	31.9	31.9	31.9	31.9
Mercury (Inorganic) (Japanese quail - NOAEL)	0.16	0.16	0.16	0.16	0.16	0.16	0.16	0.24	0.24	0.24	0.24
Mercury (Inorganic) (Chicken - NOAEL)	2.02	2.02	2.02	2.02	2.02	2.02	2.02	3.03	3.03	3.03	3.03
Mercury (Organic) (American black duck - AEL)	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031
Mercury (Organic) (Mallard - LOAEL)	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
Mercury (Organic) (Pheasant - AEL)	0.004	0.004	0.004	0.004	0.004	0.004	0.004	0.0059	0.0059	0.0059	0.0059
Mercury (Organic) (Pheasant - LOAEL)	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.008	0.008	0.008	0.008
Nickel (Chicken - NOAEL)	2.1	2.1	2.1	2.1	2.1	2.1	2.1	3.1	3.1	3.1	3.1
Nickel (Mallard - NOAEL)	5.83	5.83	5.83	5.83	5.83	5.83	5.83	5.83	5.83	5.83	5.83
Nickel (Mallard - NOAEL)	33	33	33	33	33	33	33	33	33	33	33
Nitrate (Turkey - FEL)	8.9	8.9	8.9	8.9	8.9	8.9	8.9	13.4	13.4	13.4	13.4
PCBs (1254) (Pheasant - LOAEL)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.11	0.11	0.11	0.11
Selenium (Black Crowned Night Heron - LOAEL)	0.10	0.10	0.10	0.16	0.16	0.16	0.16	0.10	0.10	0.10	0.10
Selenium (Chicken - NOAEL)	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.050	0.050	0.050	0.050
Selenium (Mallard - NOAEL)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Sodium nitrate (Juvenile turkeys - LOAEL)	18.3	18.3	18.3	18.3	18.3	18.3	18.3	27.5	27.5	27.5	27.5
Sulfate (Turkey - NOAEL)	8.64	8.64	8.64	8.64	8.64	8.64	8.64	12.96	12.96	12.96	12.96

**Table D4-2-2. (continued).**

Chemical	TRV for AV233	TRV for AV241	TRV for AV242	TRV for AV310	TRV for AV322	TRV for AV333	TRV for AV342	TRV for AV422	TRV for AV432	TRV for AV433	TRV for AV442
Thallium (Quail - FEL)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.07	0.07	0.07	0.07
Uranium (Black Duck - NOAEL)	13	13	13	13	13	13	13	13	13	13	13
Vanadium (Chicken - NOAEL)	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.21	0.21	0.21	0.21
Vanadium (Mallard - NOAEL)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Zinc (Chicken - LOAEL)	2.0	2.0	2.0	2.0	2.0	2.0	2.0	3.0	3.0	3.0	3.0
Zinc (Mallard - LOAEL)	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63	8.63

  

Chemical	TRV for AV233	TRV for AV241	TRV for AV242	TRV for AV310	TRV for AV322	TRV for AV333	TRV for AV342	TRV for AV422	TRV for AV432	TRV for AV433	TRV for AV442
2-butanone											
4-nitrophenol											
Anthracene											
Asbestos											
Barium											
Benzo(a)anthracene											
Benzo(a)pyrene											
Benzo(b)fluoranthene											
Benzo(g,h,i)perylene											
Benzo(k)fluoranthene											
Benzoic acid											
Butylbenzylphthalate											
Chloride											
Chrysene											
Di-2-ethylhexyl-phthalate											
Di-n-butylphthalate											
Di-n-octylphthalate											
Diethyl phthalate											
Fluoranthene											
Methylene chloride											
Pentachlorophenol											
Phenanthrene											
Pyrene											
Silver											
Sulfide											
Tetrachloroethane											
Toluene											
Trans-1,3-dichloropropene											
Trichloroethylene											
Xylenes											

a. Route of exposure through intraperitoneal injection. See Appendix D4 Attachment 2A.

No data located for:

- 2-butanone
- 4-nitrophenol
- Anthracene
- Asbestos
- Barium
- Benzo(a)anthracene
- Benzo(a)pyrene

**Appendix D4  
Attachment 2A**

**Contaminants of Potential Concern**

**COPC:** 1,1-Dichloroethylene CAS 75-34-4

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Inhalation

**Test Endpoint:** NOAEL

**Reference:** Hoffman, H.T., H. Birnstiel, and P. Jobst, 1970, "Inhalation toxicity of 1,1- and 1,2-dichloroethane," *Archives of Environmental Contamination and Toxicology*, 17:33-37, as cited in EPA, 1993.

**QCE:** 256 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	No juveniles tested, but adult males and females tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	2	2	2	Subchronic (13-week) exposure
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Inhalation exposure. Multiple endpoints not measured. Supporting chronic studies on inhalation lacking.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	256	256	256	QCE = quantified critical endpoint
TRV	21.3	10.7	7.11	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	21.3	Test organism is in the same order and trophic level as the functional group members	none
2	10.7	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	7.11	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** 1,1 Dichloroethylene CAS 75-34-4

**Test Organisms:** Beagle Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Diet (gelatin capsules)

**Test Endpoint:** NOAEL

**Reference:** Quast, J.F., C.G. Humiston, C.E. Wade, et al., 1983, "A chronic toxicity and oncogenicity study in rats and subchronic toxicity study in dogs on ingested vinylidene chloride," *Fund. Applied Toxicology*, 3:55-62.

**QCE:** 25 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Four males and females per dose were tested. No juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (mortality, weight gain, food consumption).
Q <sub>2</sub>	1	1	1	Chronic (97-day) exposure
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Study used small number of test animals. Number of endpoints measured not known. The existence of corroborative chronic or subchronic studies for ingestion is not known.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	25	25	25	QCE = quantified critical endpoint
TRV	6.3	3.1	2.1	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.3	Test organism is in the same order and trophic level as the functional group members	M422A
2	3.1	Test organism is in a different order and same trophic level from the functional group members	M422
3	2.1	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:** 1,1 Dichloroethylene CAS 75-34-4

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Inhalation

**Test Endpoint:** NOAEL

**Reference:** Quast, J.F., C.G. Humiston, C.E. Wade, et al., 1983, "A chronic toxicity and oncogenicity study in rats and subchronic toxicity study in dogs on ingested vinylidene chloride," *Fund. Applied Toxicology*, 3:55-62.

**QCE:** 30 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate number (160) of male and females tested. No development tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (mortality, weight gain, food consumption).
Q <sub>2</sub>	1	1	1	Chronic (2 year) exposure
Q <sub>3</sub>	1	1	1	NOAEL, lipid accumulation (midzonal)
U	2	2	2	Good design, various endpoints studied, but no reproductive endpoints examined.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	30	30	30	QCE = quantified critical endpoint
TRV	7.5	3.8	2.5	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	7.5	Test organism is in the same order and trophic level as the functional group members	none
2	3.8	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.5	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** 1,1,1 Trichloroethane CAS 71-55-6

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in water

**Test Endpoint:** NOAEL

**Reference:** Lane, R.W., B.L. Riddle, and J.F. Borzelleca, 1982, "Effects of 1,2-dichloroethane and 1,1,1-trichloroethane in drinking water on reproduction and development in mice," *Toxicol. Applied Pharmacology*, 63: 409-421.

**QCE:** 1000 mg/kg-day body weight 0.035 kg (from study) water consumption: 6ml/d (from study).

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Study exposure through 2 generations and included critical life stages.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (pup survival, weight gain, fertility, gestation, viability, lactation).
Q <sub>2</sub>	1	1	1	Chronic
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Because no significant differences were observed at any dose level the maximum dose considered was a NOAEL.
M	0.5	0.5	0.5	Placed in the drinking water.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	1000	1000	1000	QCE = quantified critical endpoint
TRV	1000	500	333	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1000	Test organism is in the same order and trophic level as the functional group members	none
2	500	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	333	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** 1,1,2,2-Tetrachloroethane CAS 79-34-5

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage in corn oil)

**Test Endpoint:** FEL

**Reference:** National Cancer Institute (NCI), 1978, "Bioassay of 1,1,2,2-tetrachloroethane for possible carcinogenicity," US Department of Health, Education, and Welfare, Pub. No. 78-827.

**QCE:** 142 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Juveniles were not tested
Q <sub>1</sub>	0.5	0.5	0.5	Cancer used as endpoint
Q <sub>2</sub>	1	1	1	Chronic exposure (78 weeks)
Q <sub>3</sub>	3	3	3	Frank effect level
U	2	2	2	Number of animals tested adequate. Malignancies increased as a function of dose and the increase was significant at both dose levels. Supporting chronic toxicity studies with other species are lacking.
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	142	142	142	QCE = quantified critical endpoint
TRV	23.7	11.8	7.89	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	23.7	Test organism is in the same order and trophic level as the functional group members	none
2	11.8	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	7.89	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** 1,2,4-Trichlorobenzene CAS 120-82-1

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** Carlson, G.P., and R.G., Tardiff, 1976, "Effect of chlorinated benzenes on the metabolism of foreign organic compounds," *Toxicology and Applied Pharmacology*, 36:383-394.  
Kitchin, K.T. and M.T. Ebron, 1980, "Maternal hepatic and embryonic effects of 1,2,4-trichlorobenzene in the rat, rabbit, and beagle dog," *Environmental Research*, 31:362-373.

**QCE:** 20 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only males tested in Carlson and Tardiff (1976). Only females in Kitchin and Ebron (1980).
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (metabolism).
Q <sub>2</sub>	2	2	2	90 day chronic exposure and 14 day acute exposure
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Long-term effects in parents not studied. Small number of animals tested. No follow up studies of dosing for good NOAEL.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	20	20	20	QCE = quantified critical endpoint
TRV	1.7	0.83	0.56	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.7	Test organism is in the same order and trophic level as the functional group members	none
2	0.83	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.56	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** 2-Butanone (Methyl ethyl ketone) CAS 78-93-3

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral via drinking water

**Test Endpoint:** NOAEL

**Reference:** Cox, G.E., D.E. Barley, and K. Morganreidge, 1975, *Toxicity Studies in Rats With 2-Butanol Including Growth, Reproduction, and Teratologic Observations*, Food and Drug Research Laboratories, Inc., Report No. 91MR R 1673, Waverly, New York.

**QCE:** 1771 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Multigenerational, multi-sex study
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic study, 9 weeks per generation
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Numerous development endpoints measured. Long-term effects in parents not studied. Adequate number of animals tested. Supporting chronic toxicity studies with other species are lacking.
M	0.5	0.5	0.5	Placed in the drinking water.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	1771	1771	1771	QCE = quantified critical endpoint
TRV	885.5	442.8	295.2	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	885.5	Test organism is in the same order and trophic level as the functional group members	none
2	442.8	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	295.2	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132, M210, M210A, M222, M322

**COPC:** 2-Chlorotoluene CAS 108-41-8

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** NOAEL

**Reference:** Gibson, W. R., F. O. Gossett, G. R. Koeing, F. Marroquin, 1974a, *The Toxicity of Daily Oral Doses of O-Chlorotoluene in the Rat*, Toxicol. Division, Lilly Research Labs, /Submitted to Test Rules Dev. Branch, office of Toxic Substances, EPA, Washington, D.C.

**QCE:** 20 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Male and female juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic (103-day) exposure
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Long-term, developmental, and reproductive effects not studied. Adequate number of animals tested. Supporting chronic toxicity studies with other species are lacking.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	20	20	20	QCE = quantified critical endpoint
TRV	10	5.0	3.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	10	Test organism is in the same order and trophic level as the functional group members	none
2	5.0	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	3.3	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132, M210, M210A, M222, M322

**COPC:** **2-Propanol** CAS 67-63-0

**Test Organisms:** Rat and mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in water

**Test Endpoint:** NOAEL

**Reference:** IARC Cancer Review, 1977, Animal Inadequate Evidence IMEMDT, 15:223, IARC Monographs Evaluation Carcinogenicity Inadequate Evidence.

**QCE:** 1300 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Number of test animals not reported.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (appetite affected).
Q <sub>2</sub>	1	1	1	Chronic
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Corroborative chronic and subchronic studies to support these findings are not available.
M	0.5	0.5	0.5	Placed in the drinking water.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	1300	1300	1300	QCE = quantified critical endpoint
TRV	650	325	217	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	650	Test organism is in the same order and trophic level as the functional group members	none
2	325	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	217	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** 2,3,7,8-Tetrachloro Dibenzodioxin (TCDD) CAS 51207-31-9

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** Murray, F.J. et al., 1979, "Three-generation reproduction study of rats given 2,3,7,8-tetrachlorodibenzo-p-dioxin (TCDD) in the diet," *Toxicol. Applied Pharmacology*, 50:241-252.

**QCE:** 1E-6 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate number of male and female rats, and juveniles were also tested (three generations)
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (fertility, neonatal survival).
Q <sub>2</sub>	1	1	1	Long-term (3 generations, > 1 year) including critical life stages (reproduction).
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	No receptor or endocrine specific measures.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1E-6	1E-6	1E-6	QCE = quantified critical endpoint
TRV	1E-6	5E-7	3E-7	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1E-6	Test organism is in the same order and trophic level as the functional group members	none
2	5E-7	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	3E-7	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** 2,3,7,8-Tetrachloro Dibenzodioxin (TCDD) CAS 51207-31-9

**Test Organisms:** Ring-necked pheasants (Omnivore, Order-Galliformes)

**Exposure Medium:** Intraperitoneal injection

**Test Endpoint:** NOAEL

**Reference:** Nosek, J.A., S.R. Craven, J.R. Sullivan, S.S. Hurley, and R.E. Peterson, 1992, "Toxicity and reproductive effects of 2,3,7,8-tetrachlorodibenzo-p-dioxin in ring-necked pheasant hens," *J. Toxicol. Environmental Health*, 35:187-198.

**QCE:** 1.4E-5 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	7 females per dose tested
Q <sub>1</sub>	0.1	0.1	0.1	Intraperitoneal injection unlikely in field (mortality, egg production, hatchability).
Q <sub>2</sub>	1	1	1	10 weeks and during a critical life stage (reproduction)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Reasonable study design, looked at reproduction.
Total AF	0.2	0.4	0.6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.4E-5	1.4E-5	1.4E-5	QCE = quantified critical endpoint
TRV	7.0E-5	3.5E-5	2.3E-5	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	7.0E-5	Test organism is in the same order and trophic level as the functional group members	none
2	3.5E-5	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	2.3E-5	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:** 2,4-Dichlorophenoxyacetic acid (2,4-D) CAS 94-75-7

**Test Organisms:** Rat and mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** EPA, 1983, *2-Year Rat Oral Bioassay*, Dow Chemical Co., Acc. No. 251473, Washington, DC.

**QCE:** 1.0 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	200 Fischer 344 rats (both sexes) and 200 B6C3F1 mice.
Q <sub>1</sub>	1	1	1	2,4-D added to diet chow.
Q <sub>2</sub>	1	1	1	Chronic (91 day) study
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Adequate number of animals of each sex were used, four doses were given, and a good number of parameters were measured. Several studies support both the observation of critical toxic effects and the levels at which they occur.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.0	1.0	1.0	QCE = quantified critical endpoint
TRV	1.0	0.50	0.33	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.0	Test organism is in the same order and trophic level as the functional group members	none
2	0.50	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.33	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** 2,4-Dimethylphenol CAS 105-67-9

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** NOAEL

**Reference:** US EPA, 1989, *Ninety-Day Gavage Study in Albino Mice Using 2,4-dimethylphenol*. Study No. 410-2831, prepared by Dynamic Corporation, Rockville, MD, for the Office of Solid Wasted and Engineering Response, Washington, DC.

**QCE:** 50 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Multi-sex study with three dose levels
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (appetite affected).
Q <sub>2</sub>	1	1	1	Chronic (90 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Because no significant differences were observed at the two lowest dose levels the median dose level was considered a NOAEL
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	50	50	50	QCE = quantified critical endpoint
TRV	50	25	17	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	50	Test organism is in the same order and trophic level as the functional group members	none
2	25	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	17	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** 2,4-Dinitrotoluene CAS 121-14-2

**Test Organisms:** Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Gelatin capsule

**Test Endpoint:** NOAEL

**Reference:** Ellis, H.V. et al., 1985, "Subchronic and chronic toxicity studies of 2,4-dinitrotoluene. Part I. Beagle dogs," *J. of the American College of Tox.*, 4(4):233-242.

**QCE:** 0.20 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate number (48 total) of male and females tested, but no juveniles.
Q <sub>1</sub>	1	1	1	Endpoint expected to be ecologically significant (neuropathy, mortality).
Q <sub>2</sub>	1	1	1	Chronic study (2 years)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Good design
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.2	0.2	0.2	QCE = quantified critical endpoint
TRV	0.10	0.05	0.03	Toxicity Reference Value = QCE/Total AF

  

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.10	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.05	Test organism is in a different order and same trophic level from the functional group members	M322, M422
3	0.03	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222

**COPC:** 4-Chloroaniline CAS 106-47-8

**Test Organisms:** Rat and Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** LOAEL Spleen lesions; increased mortality

**Reference:** National Cancer Institute (NCI), 1979, *Bioassay of p-Chloroaniline for Possible Carcinogenicity*, NCI Carcinogenesis Technical Report Series No. 189, NTIS, PB-295896.

**QCE:** 12.5 mg/kg/day Adjusted for treatment schedule

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	No juveniles tested but adult males and females tested
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic (78-week) exposure
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Adequate number of animals from two species tested. Multiple endpoints (cancer and non-cancer) tested. Supporting studies on possible reproductive or developmental effects are lacking. A NOAEL was not established.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	12.5	12.5	12.5	QCE = quantified critical endpoint
TRV	1.56	0.78	0.52	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.56	Test organism is in the same order and trophic level as the functional group members	none
2	0.78	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.52	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** 4-Methylphenol (p-Cresol) CAS 106-44-5

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** NOAEL

**Reference:** EPA, 1987b, *O-, M-, P- Cresol. 90-Day Oral Subchronic Study in Rats*, Office for Solid Waste, Washington, DC.

**QCE:** 50 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Age and sex of test animals not known.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic (90-day) exposure
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Corroborative chronic and subchronic studies to support these findings are not available.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	50	50	50	QCE = quantified critical endpoint
TRV	13	6.3	4.2	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	13	Test organism is in the same order and trophic level as the functional group members	none
2	6.3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	4.2	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** 4-Chloro-3-methylphenol (CMP) CAS 59-50-7

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** EPA, 1987b, *O-, M-, P-Cresol. 90 Day Oral Subchronic Study in Rats*, Office for Solid Waste, Washington, DC.

**QCE:** 200 mg/kd-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	10 each males and females were tested, not juveniles.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (food consumption).
Q <sub>2</sub>	2	2	2	Subchronic (21 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Study used small number of test animals, and was of subchronic duration. Corroborative chronic and subchronic studies to support these findings are not available.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	200	200	200	QCE = quantified critical endpoint
TRV	17	8.3	5.6	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	17	Test organism is in the same order and trophic level as the functional group members	none
2	8.3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	5.6	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Acenaphthene CAS 83-32-9

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** NOAEL

**Reference:** EPA, 1980, *Mouse Oral Subchronic Study with Acenaphthene*, Study conducted by Hazleton Laboratories Inc. for the Office of Solid Waste, Washington, DC.

**QCE:** 175 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	20 each sex/treatment group evaluated. No juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic (90-day) study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Numerous endpoints measured. Adequate number of animals tested. Supporting chronic toxicity and reproductive studies are lacking.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	175	175	175	QCE = quantified critical endpoint
TRV	43.8	21.9	14.6	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	43.8	Test organism is in the same order and trophic level as the functional group members	none
2	21.9	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	14.6	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** Acetone CAS 67-64-1

**Test Organisms:** Rat and Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** NOAEL

**Reference:** EPA, 1986, *Ninety-Day Gavage Study in Albino Rats Using Acetone*, Office of Solid Waste, Washington, DC.

**QCE:** 100 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	30 each sex/treatment group evaluated. No juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic (90-day) study
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Numerous endpoints measured. Adequate number of animals tested. Supporting chronic toxicity and reproductive studies are lacking.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	100	100	100	QCE = quantified critical endpoint
TRV	25	13	8.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	25	Test organism is in the same order and trophic level as the functional group members	none
2	13	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	8.3	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** Acetonitrile CAS 75-05-8

**Test Organisms:** Hamsters (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** LOAEL

**Reference:** Willhite, C.C., 1983, "Developmental toxicology of acetonitrile in the Syrian golden hamster," *Teratology*, 27: 313-325.

**QCE:** 100 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Groups of 6-8 pregnant golden hamsters treated by gavage with 1, 100, 200, 300, or 400 mg/kg of acetonitrile on gestation day 8.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (mortality).
Q <sub>2</sub>	3	3	3	Short-term (1 day) exposure
Q <sub>3</sub>	2	2	2	LOAEL - embryo development
U	2	2	2	Reasonable design, reproductive, and sensitive life stage examined, but no NOAEL determined. Small reproduction analysis, poor follow up.
Total AF	24	48	72	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	100	100	100	QCE = quantified critical endpoint
TRV	4.2	2.1	1.4	Toxicity Reference Value = QCE/Total AF

R	TRV		
1	4.2	Test organism is in the same order and trophic level as the functional group members	none
2	2.1	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	1.4	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** Acetonitrile CAS 75-05-8

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** NOAEL

**Reference:** International Research and Development Corp. (IRDC), 1981, *Acetonitrile, Teratology study in rats*, Unpublished study sponsored by Monsanto Company.

**QCE:** 190 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Groups of 25 Charles River rats treated by gavage with 0, 124, 190, or 275 mg/kg-day of acetonitrile on gestation days 6 to 19.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic (14 day) study
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Inadequate information, unpublished study.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	190	190	190	QCE = quantified critical endpoint
TRV	16	7.9	5.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	16	Test organism is in the same order and trophic level as the functional group members	none
2	7.9	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	5.3	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** Acetonitrile CAS 75-05-8

**Test Organisms:** Rat and mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Inhalation

**Test Endpoint:** NOAEL

**Reference:** National Toxicology Program (NTP), 1983, *90-day subchronic toxicity study of acetonitrile in Fischer 344 rats and B6C3F1 mice*, prepared by Hazelton Labs America, Inc.

**QCE:** 38.6 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	10 male and 10 female Fischer 344 rats and 10 male and 10 female B6C3F1 mice evaluated.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic (90 day) study
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Adequate numbers of animals of both sexes employed with adequate controls and appropriate endpoints.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	38.6	38.6	38.6	QCE = quantified critical endpoint
TRV	19.3	9.65	6.43	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	19.3	Test organism is in the same order and trophic level as the functional group members	none
2	9.65	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	6.43	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** Acrylonitrile CAS 107-13-1

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Drinking water

**Test Endpoint:** NOAEL

**Reference:** Biodynamics, 1980, *A Twenty-Four Month Oral Toxicity/Carcinogenicity Study of Acrylonitrile Administered to Spartan Rates in the Drinking Water*, Biodynamics, Inc., Division of Biology and Safety Evaluation, East Millstone, NJ, Project # BDN-77-28.

**QCE:** 0.14 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Both male and female studies.
Q <sub>1</sub>	1	1	1	Reproductive endpoint, increased testes weight.
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Good design. Results supported by Tandon et al., 1988.
M	0.5	0.5	0.5	Placed in the drinking water.
Total AF	0.5	1.0	1.5	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	0.14	0.14	0.14	QCE = quantified critical endpoint
TRV	0.28	0.14	0.09	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.28	Test organism is in the same order and trophic level as the functional group members	none
2	0.14	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.09	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Acrylonitrile CAS 107-13-1

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** LOAEL

**Reference:** Tandon, R., et al., 1988, "Testicular effects of acrylonitrile in mice," *Toxicology Letters*, 42:55-63.

**QCE:** 10 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Variability is moderate because other studies list this QCE as a NOAEL.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic (60-days)
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Number of test organisms unknown
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	10	10	10	QCE = quantified critical endpoint
TRV	1.3	0.63	0.42	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.3	Test organism is in the same order and trophic level as the functional group members	none
2	0.63	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.42	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Aluminum CAS 7429-90-5

**Test Organisms:** Bovine (Herbivore, Order-Artiodactyla)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Valdivia, R., C.B. Ammerman, C.J. Wilcox, and P.R. Henry, 1978, "Effect of dietary aluminum on animal performance and tissue mineral levels in growing steers," *Journal of Animal Science*, 47:1351, as cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals, Washington, DC.\*

**QCE:** 15.3 mg/kg-day                      1200mg/kg food\* 6.33kg food/day (cited)/262kgBW (52.94% Aluminum) (cited)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only males tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoints (food consumption, body weights)
Q <sub>2</sub>	1	1	1	Chronic study (84 days)
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages not examined. NOAEL established. Test organisms exposed to AlCl <sub>3</sub> ·6H <sub>2</sub> O (calculated as Aluminum only)
M	0.5	0.5	0.5	Dry feed spiked with Aluminum chloride, very soluble.
Total AF	3	6	9	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	15.3	15.3	15.3	QCE = quantified critical endpoint
TRV	5.10	2.55	1.70	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	5.10	Test organism is in the same order and trophic level as the functional group members	none
2	2.55	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	1.70	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

\* Also used to evaluate aluminum chloride

**COPC:** Aluminum CAS 7429-90-5

**Test Organisms:** Rabbit (Herbivore, Order-Lagomorpha)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Nekipelov, M.K, 1966, "Hygienic standard for aluminum nitrate in water basins," *Hyg. Sanit. (USSR)*, 31:204, as cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals, Washington, DC.\*

**QCE:** 0.145 mg/kg-day (as aluminum)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on sex, age, and number of animals tested unknown.
Q <sub>1</sub>	0.5	0.5	0.5	Endpoint could occur, but of uncertain ecological significance
Q <sub>2</sub>	1	1	1	Chronic study (6 months)
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Limited information. No reproductive endpoint or sensitive life stage examined. NOAEL established. Test organisms fed Al(NO <sub>3</sub> ) <sub>2</sub> (calculated as aluminum only).
Total AF	4.5	9	13.5	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.145	0.145	0.145	QCE = quantified critical endpoint
TRV	0.032	0.016	0.011	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.032	Test organism is in the same order and trophic level as the functional group members	none
2	0.016	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.011	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

\* Also used to evaluate aluminum nitrate

**COPC:** Aluminum CAS 7429-90-5

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** LOAEL

**Reference:** Paternain, J.L., J.L. Domingo, J.M., Llober, J. Corbella, 1988, "Embryotoxic and teratogenic effects of aluminum nitrate in rats upon oral administration," *Teratology*, 38:253-257.\*

**QCE:** 26.1 mg/kg-day (as aluminum)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only ten pregnant rats for each dose, and no males, were tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (mortality).
Q <sub>2</sub>	1	1	1	Chronic study (dose given days 6 to 14 of pregnancy)
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Limited information but reproductive endpoints and sensitive life stage (offspring) examined. No NOAEL established.
M	0.5	0.5	0.5	Soluble Aluminum nitrate given by gavage (calculated as aluminum only)
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	26.1	26.1	26.1	QCE = quantified critical endpoint
TRV	6.53	3.26	2.18	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.53	Test organism is in the same order and trophic level as the functional group members	none
2	3.26	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.18	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

\* Also used to evaluate aluminum nitrate

**COPC:** Aluminum CAS 7429-90-5

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** Adverse effect level - significantly retarded growth in young

**Reference:** Thurston, H., G.R. Gilmore, and J.E. Swales, 1972, "Aluminum retention and toxicity in chronic renal failure," *The Lancet*, 1: 881-883.\*

**QCE:** 57.1 mg/kg-day (as aluminum) (8 mg/rat-day/0.036 kg BW)\*\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	3 to 4-week old animals tested, sex not specified.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (growth)
Q <sub>2</sub>	2	2	2	Subchronic duration (4 weeks)
Q <sub>3</sub>	3	3	3	AEL-reduced growth rate, increased bone aluminum concentrations
U	2	2	2	Sensitive life stage examined. No NOAEL established. Test animals exposed to aluminum hydroxide (calculated as aluminum only).
M	0.5	0.5	0.5	Feed was spiked with highly soluble form of metal salt, not consistent with soil forms. Experimental bioavailability expected to be substantially enhanced compared to environmental exposures.
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	57.1	57.1	57.1	QCE = quantified critical endpoint
TRV	9.5	4.8	3.2	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	9.5	Test organism is in the same order and trophic level as the functional group members	none
2	4.8	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	3.2	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

\* Also used to evaluate aluminum hydroxide

\*\*BW and ingestion rate specified in the article

**COPC:** Aluminum CAS 7429-90-5

**Test Organisms:** Turkeys (Omnivore, Order-Galliformes)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Cakir, A., T.W. Sullivan, and F.B. Mather, 1978, "Alleviation of fluorine toxicity in starting turkeys and chicks with aluminum," *Poultry Science* 57:498, as cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals, Washington, DC.\*

**QCE:** 182.3 mg/kg-day (as aluminum)

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	1-day old turkeys tested. Secondary source so information on number of animals tested not available.
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic study (28 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Limited information. Sensitive life stage examined. NOAEL established. Test organisms exposed to Al <sub>2</sub> (SO <sub>4</sub> )·18H <sub>2</sub> O (calculated as aluminum).
Total AF	8	16	24	R * I * Q <sub>1</sub> * Q <sub>2</sub> * Q <sub>3</sub> * U = Total AF
QCE (mg/kg-day)	182.3	182.3	182.3	QCE – quantified critical endpoint
TRV	22.79	11.39	7.60	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	22.79	Test organism is in the same order and trophic level as the functional group members	none
2	11.39	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	7.60	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\* Also used to evaluate aluminum sulfate

**COPC:** Aluminum CAS 7429-90-5

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Miller, D. and R.R. Kifer, 1970, "Effect of glutamic acid and antacids on chick bioassay of protein quality of fish meals," *Poultry Science* 49:1327, as cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals, Washington, DC.\*

**QCE:** 900 mg/kg-day (as aluminum)

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	180 1-day old chicks tested
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic study (19 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Limited information. Sensitive life stage examined. NOAEL established. Test organisms exposed to Al(OH) <sub>3</sub> (calculated as aluminum only).
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	900	900	900	QCE = quantified critical endpoint
TRV	230	110	75	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	230	Test organism is in the same order and trophic level as the functional group members	none
2	110	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	75	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\* Also used to evaluate aluminum hydroxide

**COPC:****Aluminum chloride CAS 7446-70-0****Test Organisms:**

Bovine (Herbivore, Order-Artiodactyla)

**Exposure Medium:**

Oral in diet

**Test Endpoint:**

NOAEL

**Reference:**Valdivia, R., C.B. Ammerman, C.J. Wilcox, and P.R. Henry, 1978, "Effect of dietary aluminum on animal performance and tissue mineral levels in growing cattle," *Journal of Animal Science*, 47:1351, as cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals, Washington, DC.**QCE:**

28.9 mg/kg-day as aluminum chloride 1200mg/kg food\* 6.33kg food/day (cited) /262 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only males tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoints
Q <sub>2</sub>	1	1	1	Chronic study (84 days)
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages not examined. NOAEL established. Test organisms exposed to AlCl <sub>3</sub> ·6H <sub>2</sub> O
M	0.5	0.5	0.5	Dry feed spiked with aluminum chloride, very soluble.
Total AF	3	6	9	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	28.9	28.9	28.9	QCE = quantified critical endpoint
TRV	9.63	4.82	3.21	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	9.63	Test organism is in the same order and trophic level as the functional group members	none
2	4.82	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	3.21	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Aluminum hydroxide CAS 21645-51-2

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Miller, D. and R.R. Kifer, 1970, "Effect of glutamic acid and antacids on chick bioassay of protein quality of fish meals," *Poultry Science* 49:1327, as cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals, Washington, DC.

**QCE:** 3,500 mg/kg-day (as Al(OH)<sub>3</sub>)

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	180 1-day old chicks tested
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic study (19 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Limited information. Sensitive life stage examined. NOAEL established. Test organisms exposed to Al(OH) <sub>3</sub> .
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3,500	3,500	3,500	QCE = quantified critical endpoint
TRV	875	438	292	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	875	Test organism is in the same order and trophic level as the functional group members	none
2	438	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	292	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:** Aluminum hydroxide CAS 21645-51-2

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** Adverse effect level - significantly retarded growth in young

**Reference:** Thurston, H., G.R. Gilmore, and J.E. Swales, 1972, "Aluminum retention and toxicity in chronic renal failure," *The Lancet*, 1: 881-883.

**QCE:** 222 mg/kg-day (as aluminum hydroxide) (8 mg/rat-day)/0.036kgBW\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	3 to 4-week old animals tested, sex not specified.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (growth).
Q <sub>2</sub>	2	2	2	Subchronic duration (4 weeks)
Q <sub>3</sub>	3	3	3	AEL-reduced growth rate, increased bone aluminum concentrations
U	2	2	2	Sensitive life stage examined. No NOAEL established. Test animals exposed to aluminum hydroxide.
M	0.5	0.5	0.5	Feed was spiked with highly soluble form of metal salt, not consistent with soil forms. Experimental bioavailability expected to be substantially enhanced compared to environmental exposures.
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	222	222	222	QCE = quantified critical endpoint
TRV	37.0	18.5	12.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	37.0	Test organism is in the same order and trophic level as the functional group members	none
2	18.5	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	12.3	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

\*BW and ingestion rate specified in the article

**COPC:** Aluminum nitrate CAS 13473-90-0

**Test Organisms:** Rabbit (Herbivore, Order-Lagomorpha)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Nekipelov, M.K, 1966, "Hygienic standard for aluminum nitrate in water basins," *Hyg. Sanit. (USSR)*, 31:204, as cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals, Washington, DC.

**QCE:** 1.0 mg/kg-day (as aluminum nitrate)

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on sex, age, and number of animals tested unknown.
Q <sub>1</sub>	0.5	0.5	0.5	Endpoint could occur, but of uncertain ecological significance
Q <sub>2</sub>	1	1	1	Chronic study (6 months)
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Limited information. No reproductive endpoint or sensitive life stage examined. NOAEL established. Test organisms fed Al(NO <sub>3</sub> ) <sub>2</sub> .
Total AF	4.5	9	13.5	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.0	1.0	1.0	QCE = quantified critical endpoint
TRV	0.22	0.11	0.07	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.22	Test organism is in the same order and trophic level as the functional group members	none
2	0.11	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.07	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Aluminum nitrate CAS 13473-90-0

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** LOAEL - Developmental abnormalities, including death, in offspring

**Reference:** Paternain, J.L., J.L. Domingo, J.M., Llober, J. Corbella, 1988, "Embryotoxic and teratogenic effects of aluminum nitrate in rats upon oral administration," *Teratology*, 38:253-257.

**QCE:** 180 mg/kg-day (as aluminum nitrate)

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only ten pregnant rats for each dose, and no males, were tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (mortality).
Q <sub>2</sub>	1	1	1	Chronic study (dose given days 6 to 14 of pregnancy)
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Limited information but reproductive endpoints and sensitive life stage (offspring) examined. No NOAEL established.
M	0.5	0.5	0.5	Soluble Aluminum nitrate given by gavage
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	180	180	180	QCE = quantified critical endpoint
TRV	45	23	15	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	45	Test organism is in the same order and trophic level as the functional group members	None
2	23	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	15	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** Aluminum sulfate CAS 10043-01-3

**Test Organisms:** Turkeys (Omnivore, Order-Galliformes)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Cakir, A., T.W. Sullivan, and F.B. Mather, 1978, "Alleviation of fluorine toxicity in starting turkeys and chicks with aluminum," *Poultry Science* 57:498, as cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals, Washington, DC.

**QCE:** 324 mg/kg-day [as Al<sub>2</sub>(SO<sub>4</sub>)·18H<sub>2</sub>O]

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	1-day old turkeys tested. Secondary source so information on number of animals tested not available.
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic study (28 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Limited information. Sensitive life stage examined. NOAEL established. Test organisms exposed to Al <sub>2</sub> (SO <sub>4</sub> )·18H <sub>2</sub> O
Total AF	8	16	24	R * I * Q <sub>1</sub> * Q <sub>2</sub> * Q <sub>3</sub> * U = Total AF
QCE (mg/kg-day)	324	324	324	QCE = quantified critical endpoint
TRV	40.5	20.3	13.5	Toxicity Reference Value = QCE/Total AF

**Appropriate Functional Groups:**

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	40.5	Test organism is in the same order and trophic level as the functional group members	none
2	20.3	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	13.5	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:** Ammonia CAS 7664-41-7

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** LD50

**Reference:** Environment Canada, 1981, *Tech Inf. for Problem Spills: Ammonia (Draft)*, p. 103.

**QCE:** 350 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	No information.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (mortality).
Q <sub>2</sub>	3	3	3	No information.
Q <sub>3</sub>	3	3	3	LD50
U	3	3	3	Incomplete information.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	350	350	350	QCE = quantified critical endpoint
TRV	4.3	2.2	1.4	Toxicity Reference Value = QCE/Total AF

**Appropriate Functional Groups:**

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	4.3	Test organism is in the same order and trophic level as the functional group members	none
2	2.2	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	1.4	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** Anthracene CAS 120-12-7

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral gavage

**Test Endpoint:** NOAEL

**Reference:** U.S. EPA, 1989, *Subchronic toxicity in mice with anthracene*, Final Report, Hazelton Laboratories America, Inc. Prepared for the Office of Solid Waste, Washington, DC.

**QCE:** 1000 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Subchronic toxicity studies with adequate numbers of animals.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Lacks reproductive/developmental data
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1000	1000	1000	QCE = quantified critical endpoint
TRV	125	62.5	41.7	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	125	Test organism is in the same order and trophic level as the functional group members	none
2	62.5	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	41.7	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** Antimony (Antimony Potassium Tartrate) CAS 7440-36-0

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Drinking water

**Test Endpoint:** LOAEL Apparent slight decrease in life span of female CD-1 mice (significance unknown)

**Reference:** Schroeder, H.A., M. Mitchner, and J.J. Balassa, 1968, "Zirconium, niobium, antimony and fluorine in mice: effects of growth survival and tissue levels," *Journal of Nutrition*, 95:95-101.  
Kanisawa, M. and H.A. Schroeder, 1969, "Life term studies on the effect of trace elements on spontaneous tumor in mice and rats," *Cancer Research*, 29(4):892-895.

**QCE:** 1.25 mg/kg-day (5 mg/L water)(7.5 mL water/day)(1L/1000mL)/0.03 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals.
Q <sub>1</sub>	0.5	0.5	0.5	Endpoint could occur, but of uncertain ecological significance
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	2	2	2	LOAEL endpoint
U	2	2	2	Large chronic study, but no reproductive endpoints examined.
M	0.5	0.5	0.5	Soluble salts in the drinking water were used
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	1.25	1.25	1.25	QCE = quantified critical endpoint
TRV	1.25	0.625	0.417	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.25	Test organism is in the same order and trophic level as the functional group members	none
2	0.625	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.417	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** Arsenic CAS 7440-38-2

**Test Organisms:** Brown-headed cowbird (Insectivore, Order-Passeriformes)

**Exposure Medium:** No information available

**Test Endpoint:** Mortality

**Reference:** US Fish and Wildlife Service, 1969, Bureau of Sport Fisheries and Wildlife, Publication 74, pp. 56-57.

**QCE:** 2.46 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Males only.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (mortality)
Q <sub>2</sub>	1	1	1	Chronic (7 months)
Q <sub>3</sub>	3	3	3	Mortality
U	3	3	3	Four dose levels- both a LOAEL and NOAEL established
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.46	2.46	2.46	QCE = quantified critical endpoint
TRV	0.137	0.069	0.046	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.137	Test organism is in the same order and trophic level as the functional group members	none
2	0.069	Test organism is in a different order and same trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242
3	0.046	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Arsenic CAS 7440-38-2

**Test Organisms:** Mallard (Herbivore, Order-Anseriformes)

**Exposure Medium:** Oral

**Test Endpoint:** LOAEL

**Reference:** National Academy of Sciences (NAS), 1977, *Arsenic*, Washington, DC.

**QCE:** 25 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Calculated assuming that the mallards consume the equivalent of five percent of their body weight
Q <sub>1</sub>	1	1	1	Relevant effect (mortality).
Q <sub>2</sub>	1	1	1	Chronic study (32 days)
Q <sub>3</sub>	2	2	2	LOAEL
U	3	3	3	Old study, secondary source (supporting info only)
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	25	25	25	QCE = quantified critical endpoint
TRV	1.4	0.69	0.46	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.4	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.69	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.46	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Arsenic CAS 7740-38-2

**Test Organisms:** Domestic sheep (Herbivore, Order-Artiodactyla)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Eisler, R., 1988, *Arsenic Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, US Fish and Wildlife Service Biological Report, 85(1.12):92.

**QCE:** 2.3 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source with no data regarding variability of response.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subacute duration.
Q <sub>3</sub>	1	1	1	NOAEL endpoint.
U	3	3	3	Secondary source, only one dose level.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.3	2.3	2.3	QCE = quantified critical endpoint
TRV	0.13	0.06	0.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.13	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.04	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Arsenic CAS 7778-43-0

**Test Organisms:** Mallard (Herbivore, Order-Anseriformes)

**Exposure Medium:** Oral in diet (Arsenic as sodium arsenite)

**Test Endpoint:** NOAEL

**Reference:** U.S. Fish and Wildlife Service, 1964, *Pesticide-wildlife studies, 1963: a review of Fish and Wildlife Service investigations during the calendar year*, FWS Circular 199.

**QCE:** 5.14 mg/kg-day ((51.35mg As/kg food)\*(0.1 kg food/day))/(1kg BW)

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	Same trophic level but different order than members of functional groups
I	2	2	2	Reasonable number of animals tested
Q <sub>1</sub>	1	1	1	Mortality, is ecologically relevant
Q <sub>2</sub>	1	1	1	Chronic duration (over 128 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Multiple doses (100, 250, 500, and 1000 ppm sodium arsenite) examined with both a NOAEL and a LOAEL established. However, no reproductive endpoints examined.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5.14	5.14	5.14	QCE = quantified critical endpoint
TRV	1.29	0.64	0.43	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.29	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.64	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.43	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Arsenic CAS 7778-43-0

**Test Organisms:** Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Diet as sodium arsenite or sodium arsenate

**Test Endpoint:** NOAEL

**Reference:** Byron, W.R., et al., 1967, "Pathologic changes in rats and dogs from two-year feeding of sodium arsenite or sodium arsenate," *Toxicology and Applied Pharmacology*, 10:132-147.

**QCE:** 1.28 mg/kg-day (50 mg/kg food)\*(0.24 kg food /day)/(9.41 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Reasonable number of males and females studied (24)
Q <sub>1</sub>	1	1	1	Weight loss, survival, endpoint ecologically significant
Q <sub>2</sub>	1	1	1	Chronic study (2 years)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Reasonable study, but no reproductive endpoints examined in the two years.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.28	1.28	1.28	QCE = quantified critical endpoint
TRV	0.32	0.16	0.11	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.32	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.16	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.11	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

\*Ingestion rate specified

**COPC:** Arsenic CAS 7778-43-0

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet as sodium arsenate or sodium arsenite

**Test Endpoint:** NOAEL

**Reference:** Byron, W.R., et al., 1967, "Pathologic changes in rats and dogs from two-year feeding of sodium arsenite or sodium arsenate," *Toxicology and Applied Pharmacology*, 10:132-147.

**QCE:** 3.1mg/kg-day (62.5 mg/kg food)\*(0.0189kg/day)/(0.382 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	Different trophic level and order than members of functional groups.
I	2	2	2	300 weanling rats. Data does not show a good dose-response curve low-dose range.
Q <sub>1</sub>	1	1	1	Levels of 62.5 ppm arsenic as arsenite and 125 ppm arsenic as arsenate did not cause common bile duct enlargement and did not affect survival. Weight was slightly reduced in females at the 62.5 ppm arsenic as arsenite.
Q <sub>2</sub>	1	1	1	Chronic study.
Q <sub>3</sub>	1	1	1	NOAEL using lowest NOAEL from either arsenite or arsenate
U	2	2	2	Good overall design, but no reproductive studies in the two years.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3.1	3.1	3.1	QCE = quantified critical endpoint
TRV	0.78	0.39	0.26	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.78	Test organism is in the same order and trophic level as the functional group members	none
2	0.39	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.27	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** Arsenic CAS 7778-43-0

**Test Organisms:** Mice (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet as sodium arsenate or sodium arsenite in drinking water

**Test Endpoint:** LOAEL

**Reference:** Schroeder, H.A., and M. Mitchner, 1971, *Toxic effects of trace elements on the reproduction of mice and rats*, Arch. Environ. Health, 23:102-106.

**QCE:** 1.25 mg/kg-day ((5.00 mg As/L H<sub>2</sub>O)\*(0.0075 L/day))/(0.03kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	Different trophic level and order than members of functional groups.
I	2	2	2	3 generations, however only one dosage
Q <sub>1</sub>	1	1	1	Declining litter sized with each successive generation
Q <sub>2</sub>	1	1	1	Chronic study.
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Only one dose level, no NOAEL established.
M	0.5	0.5	0.5	Placed in drinking water
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	1.25	1.25	1.25	QCE = quantified critical endpoint
TRV	0.31	0.16	0.10	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.31	Test organism is in the same order and trophic level as the functional group members	none
2	0.16	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.10	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132 M210, M210A, M222, M322

**COPC:** Asbestos CAS 1332-21-4

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (drinking water)

**Test Endpoint:** NOAEL

**Reference:** Schneider, U. and R.R. Maurer, "Asbestos and embryonic development," *Teratology*, 15:273-80, 1977.

**QCE:** 400 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Embryo and maternal toxicity were both nonexistent.
Q <sub>1</sub>	1	1	1	Endpoint likely to occur in field (reproduction, mortality).
Q <sub>2</sub>	2	2	2	Subchronic duration (15 days).
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Studies of reasonable quality. Reproduction effects studies. Three dosage levels (4, 60, 400 mg/kg-day).
M	0.5	0.5	0.5	Placed in drinking water.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	400	400	400	QCE = quantified critical endpoint
TRV	200	100	67	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	200	Test organism is in the same order and trophic level as the functional group members	none
2	100	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	67	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Asbestos CAS 1332-21-4

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** LOAEL

**Reference:** Donham K.J., et al., 1980, "The effects of long-term ingestion of asbestos on the colon of F344 rats," *Cancer (March Suppl)*, 45:1073-84.

**QCE:** 3,947 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Low variability. Study started with F344 rats as weanlings and progressed 32 months.
Q <sub>1</sub>	0.1	0.1	0.1	Endpoint is tumors and decreased cyclic AMP level in colon.
Q <sub>2</sub>	1	1	1	Chronic duration (32 months).
Q <sub>3</sub>	2	2	2	LOAEL
U	1	1	1	High quality study. Over two hundred animals tested.
Total AF	0.2	0.4	0.6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3,947	3,947	3,947	QCE = quantified critical endpoint
TRV	19,740	9,867	6,578	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	19,740	Test organism is in the same order and trophic level as the functional group members	none
2	9,867	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	6,578	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Barium CAS 7440-39-3

**Test Organisms:** Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Oral

**Test Endpoint:** FEL LD-100

**Reference:** Venugopal, B., and T.D. Luckey, 1978, *The Toxicity of Metals in Mammals*, Plenum Press, New York.

**QCE:** 59 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	No information (secondary source)
Q <sub>1</sub>	1	1	1	Endpoint expected to be ecologically significant (mortality).
Q <sub>2</sub>	3	3	3	Acute study
Q <sub>3</sub>	3	3	3	Lethal endpoint
U	3	3	3	Acute study; no other information (secondary source)
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	59	59	59	QCE = quantified critical endpoint
TRV	0.73	0.36	0.24	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.73	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.36	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.24	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:** Barium CAS 7440-39-3

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Drinking water

**Test Endpoint:** NOAEL

**Reference:** Perry, H.M. et al., 1989, "Hypertension and associated cardiovascular abnormalities induced by chronic barium feeding," *Journal of Toxicology and Environmental Health*, 28(3):373-388.  
Kopp, S.J. et al., 1985, "Cardiovascular dysfunction and hypersensitivity to sodium pentobarbital induced by chronic barium chloride ingestion," *Toxicology and Applied Pharmacology*, 77(23):303-314.

**QCE:** 0.51 mg/kg-day (100 mg/L)\*(0.022L/day)/0.435kg BW\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals
Q <sub>1</sub>	0.5	0.5	0.5	Although endpoint examined (increased blood pressure at higher doses) could occur in ecological receptors, the absence of any effects on growth and longevity at any dose argues against its ecological relevance. But at the NOAEL dose, no hypersensitivity was observed.
Q <sub>2</sub>	1	1	1	Chronic study (16 months)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Concordant results in several detailed studies
M	0.5	0.5	0.5	Soluble salt in the drinking water was used
Total AF	0.25	0.50	0.75	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	0.51	0.51	0.51	QCE = quantified critical endpoint
TRV	2.0	1.0	0.68	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.0	Test organism is in the same order and trophic level as the functional group members	none
2	1.0	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.68	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\*BW given by an earlier Perry article, ingestion rate specified in the article

\*\*note-10ppm had some adverse effects such as an increase in blood pressure and tissue concentration.

**COPC:** Barium Chloride CAS 10361-37-2

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral gavage

**Test Endpoint:** NOAEL

**Reference:** Borzelleca, J.F., Condie Jr., L.W. and J.L. Egle Jr., 1988, "Short-term toxicity (one- and ten-day gavage) of barium chloride in male and female rats," *Journal of the American College of Toxicity*, 7(5): 675-685.

**QCE:** 209 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Groups of males and females (10 of each sex) were formed. 1 day study received deionized water (20 ml/kg body weight) and doses of 30, 100, and 300 mg/kg. 10 day study received the same water and doses of 100, 145, 209, and 300 mg/kg.
Q <sub>1</sub>	1	1	1	Body weight and selected organs (brain, spleen, lungs, thymus, kidneys, and testes or ovaries) were measured.
Q <sub>2</sub>	3	3	3	Short-term study (1 or 10 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Good use of other supporting sources, no reproductive endpoints or sensitive life stages studied.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	209	209	209	QCE = quantified critical endpoint
TRV	17.4	8.71	5.81	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	17.4	Test organism is in the same order and trophic level as the functional group members	none
2	8.71	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	5.81	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Benzene CAS 71-43-2

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** LOAEL

**Reference:** Nawrot, P.S. and R.E. Staples, 1979, "Embryofetal toxicity and teratogenicity of benzene and toluene in the mouse," *Teratology*, 19:41A.

**QCE:** 263.6 mg/kg-day [0.3mL Benzene/kg BW \* 0.8787 g Benzene/mL Benzene \* 1000mg/g] = 263.6 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Days 6-12 of gestation
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction).
Q <sub>2</sub>	3	3	3	Short duration
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Three dose levels, exposure at highest two doses (0.5 and 1.0 mL/kg/d significantly increased maternal mortality and embryonic resorption. Fetal weights were significantly reduced by all three dose levels.
Total AF	24	48	72	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	263.6	263.6	263.6	QCE = quantified critical endpoint
TRV	10.98	5.49	3.66	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	10.98	Test organism is in the same order and trophic level as the functional group members	none
2	5.49	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	3.66	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Benzene CAS 71-43-2

**Test Organisms:** Mouse and Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** FEL

**Reference:** National Toxicology Program (NTP), 1986, *Toxicology and Carcinogenesis Studies of Benzene in F344/N Rats and B6C3F Mice (Gavage Studies)*, NTP Technical Report Series No. 289, NIH Publication No. 86-2545.

**QCE:** 25 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	No juveniles of either species tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Long-term (103-week) study
Q <sub>3</sub>	3	3	3	FEL
U	2	2	2	Numerous other studies exist to support these findings. Adequate number of animals from both sexes of the two species tested.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	25	25	25	QCE = quantified critical endpoint
TRV	2.1	1.0	0.69	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.1	Test organism is in the same order and trophic level as the functional group members	none
2	1.0	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.69	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Benzine CAS 8032-32-4

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)  
**Exposure Medium:** Intravenous  
**Test Endpoint:** LD<sub>50</sub>  
**Reference:** Pharm. Chem. J., 1973, 7:765; RTECS  
**QCE:** 40 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on sex, age, and number of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (mortality).
Q <sub>2</sub>	3	3	3	Duration of exposure unknown.
Q <sub>3</sub>	3	3	3	Lethality
U	3	3	3	Limited information. No reproductive endpoint or sensitive life stage examined. No NOAEL established. Test organisms exposed intravenously versus orally.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	40	40	40	QCE = quantified critical endpoint
TRV	0.49	0.25	0.16	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.49	Test organism is in the same order and trophic level as the functional group members	none
2	0.25	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.16	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Benzo(a)anthracene (BaA) CAS 56-55-3

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage solution)

**Test Endpoint:** FEL

**Reference:** Klein, M., 1963, "Susceptibility of strain B6AF/j hybrid infant mice to tumorigenesis with 1,2-benzoanthracene, deoxycholic acid, and 3-methylcholanthrene," *Cancer Research*, 23:1701-1707.

**QCE:** 50 mg/kg-day (22.5 mg/mouse-total)\*(1 mouse/0.03125 kg BW)\*\*(total dose/15 days)\*\*\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Infant males tested. No females tested.
Q <sub>1</sub>	0.1	0.1	0.1	Cancer endpoint
Q <sub>2</sub>	1	1	1	Long-term (547-day) study
Q <sub>3</sub>	3	3	3	FEL
U	3	3	3	Statistical evaluation of data not reported.
Total AF	1.8	3.6	5.4	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	50	50	50	QCE = quantified critical endpoint
TRV	28	14	9.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	28	Test organism is in the same order and trophic level as the functional group members	none
2	14	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	9.3	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\*22.5 specified in article

\*\*BW given in Wiseman, J., "Feeding of Non-ruminant Livestock." Butterworths; Boston, MA. 1987.

\*\*\*Dose was given 3 days/week for 5 weeks = 15 days

**COPC:** Benzo(a)pyrene CAS 50-32-8

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** FEL

**Reference:** Klein, M., 1963, "Susceptibility of strain B6AF/j Hybrid infant mice to tumorigenesis with 1,2-benzanthracene, deoxycyclic acid, and 3-methylcholanthrene," *Cancer Research*, 23:1701-1707.

**QCE:** 500 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Infant males tested.
Q <sub>1</sub>	0.1	0.1	0.1	Cancer endpoint
Q <sub>2</sub>	1	1	1	Chronic (547-day) study
Q <sub>3</sub>	3	3	3	FEL
U	3	3	3	Statistical evaluation of data not reported. Number of animals tested not reported.
Total AF	1.8	3.6	5.4	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	500	500	500	QCE = quantified critical endpoint
TRV	278	139	92.6	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	278	Test organism is in the same order and trophic level as the functional group members	none
2	139	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	92.6	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Beryllium (Beryllium sulfate) CAS 7440-41-7

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Drinking water

**Test Endpoint:** NOAEL

**Reference:** Schroeder, H.A., and M. Mitchner, 1975, "Life-term studies in rats: effects of aluminum, barium, beryllium and tungsten," *J. Nutr.*, 105: 421-427.

**QCE:** 0.66mg/kg-day (5mg/L water)\*(0.046L/day)/0.35 kgBW

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (life-span, growth).
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Large chronic study, but no reproductive endpoints examined
M	0.5	0.5	0.5	Soluble salt in the drinking water used
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	0.66	0.66	0.66	QCE = quantified critical endpoint
TRV	0.66	0.33	0.22	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.66	Test organism is in the same order and trophic level as the functional group members	None
2	0.33	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.22	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\*Ingestion rate specified by EPA, 1985a.

**COPC:** **Bis(tri-*n*-butyltin)oxide CAS 56-35-9**

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Intraperitoneal injection

**Test Endpoint:** LD<sub>50</sub>

**Reference:** Davis, A. et al., 1987, "Evaluation of the genetic and embryotoxic effects of bis(tri-*n*-butyltin)oxide (TBTO), a broad-spectrum pesticide, in multiple in vivo and in vitro short-term tests," *Mutation Research*, 188: 65-95.

**QCE:** 74 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	NMRI mice used, no juveniles examined
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (mortality).
Q <sub>2</sub>	3	3	3	Short-term study (10 days)
Q <sub>3</sub>	3	3	3	LD <sub>50</sub>
U	2	2	2	Adequate study design with adequate references, limited sensitivity of endpoints for mice, looked for only drastic toxicity
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	74	74	74	QCE = quantified critical endpoint
TRV	2.1	1.0	0.69	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.1	Test organism is in the same order and trophic level as the functional group members	none
2	1.0	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.69	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M121, M123, M132, M210, M210A, M222, M322

**COPC:** Bis(tri-*n*-butyltin)oxide CAS 56-35-9

**Test Organisms:** Japanese Quail (Herbivore, Order-Galliformes)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** Schlatterer, B. et al., 1993, "Effects of bis(tri-*n*-butyltin)oxide in Japanese quail exposed during egg laying period: An interlaboratory comparison study," *Archives of Environmental Contamination and Toxicol.*, 24:440-448.

**QCE:** 6.8 mg/kg-day (60 mg/kg food)(16.9 g food/day)(1 kg/1000 g)/0.15 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	5 different labs obtained the birds from the same breeder, each group consisted of twelve mating pairs, doses of 0,24, 60, 150, or 375 mg/kg were administered.
Q <sub>1</sub>	1	1	1	Body weight, egg laying, egg mass, eggshell thickness, fertility, and other ecologically relevant endpoints measured
Q <sub>2</sub>	1	1	1	Chronic (6 weeks)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Age of the birds varied from 8 to 12 weeks between laboratories during the acclimation period. No consistent adverse effects were observed at the 60 mg/kg group so it was considered the NOAEL and the 150 mg/kg dose was considered the LOAEL.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	6.8	6.8	6.8	QCE = quantified critical endpoint
TRV	3.4	1.7	1.1	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3.4	Test organism is in the same order and trophic level as the functional group members	none
2	1.7	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	1.1	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:** Bis(tri-n-butyltin)oxide CAS 56-35-9

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral intubation

**Test Endpoint:** NOAEL

**Reference:** Davis, A., R. Barale, G. Brun, et al., 1987, "Evaluation of the genetic and embryotoxic effects of bis(tri-n-butyltin)oxide (TBTO), a broad-spectrum pesticide, in multiple in vivo short-term tests," *Muta. Res.*, 188:65-95.

**QCE:** 23.4 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate number of animals tested at six dose levels: 1.2, 3.5, 5.8, 11.7, 23.4, and 35 mg/kg/day.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	1	1	1	Chronic
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Adverse affects were not observed at lower dose levels. The study considered exposure during gestation so the 23.4 mg/kg/day dose was considered the NOAEL and the 35 mg/kg/day dose was considered the LOAEL.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	23.4	23.4	23.4	QCE = quantified critical endpoint
TRV	23.4	11.7	7.8	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	23.4	Test organism is in the same order and trophic level as the functional group members	none
2	11.7	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	7.8	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Boron CAS 7440-42-8

**Test Organisms:** Mallard Duck (Herbivore, Order-Anseriformes)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Smith, G.J. and V.P. Anders, 1989, "Toxic effects of boron on mallard reproduction," *Environmental Toxicology and Chemistry*, 8:943-950.

**QCE:** 28.8 mg/kg-day (300mg/kg food)(100g food/day)(1kg/1000g)/1 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	140 birds received a dose of 0, 30, 300, or 1000 ppm (15 birds of each sex received one of the 30, 300, or 1000 ppm doses)
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Good study design
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	28.8	28.8	28.8	QCE = quantified critical endpoint
TRV	28.8	14.4	9.6	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	28.8	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	14.4	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	9.6	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Boron CAS 7440-42-8

**Test Organisms:** Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Oral (Feed)

**Test Endpoint:** NOAEL

**Reference:** Agency for Toxic Substances and Disease Registry, 1990, *Toxicological Profile for Boron and Compounds*, Draft, US Department of Health and Human Services, October.  
Weir R.J. Jr. and R.S. Fisher, 1972, "Toxicologic studies on borax and boric acid," *Toxicol. Appl. Pharmacol.*, 23:351-364.

**QCE:** 8.75 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Males and females tested, but only 4 of each per group.
Q <sub>1</sub>	1	1	1	Endpoint expected to be ecologically significant (reproduction).
Q <sub>2</sub>	1	1	1	Chronic duration (2 years)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	The highest dose, 350ppm, was the NOAEL; therefore, a 38 week test was performed at a dose of 1170 ppm.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	8.75	8.75	8.75	QCE = quantified critical endpoint
TRV	4.36	2.19	1.46	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	4.36	Test organism is in the same order and trophic level as the functional group members	M422A
2	2.19	Test organism is in a different order and same trophic level from the functional group members	M422
3	1.46	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:** Boron CAS 7440-42-8

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (feed)

**Test Endpoint:** NOAEL

**Reference:** Agency for Toxic Substances and Disease Registry, 1990, *Toxicological Profile for Boron and Compounds*, Draft, US Department of Health and Human Services, October.  
Weir R.J. Jr. and R.S. Fisher, 1972, "Toxicologic studies on borax and boric acid," *Toxicol. Appl. Pharmacol.*, 23:351-364.

**QCE:** 17.5 mg/kg-day                      350mg/kg food\*0.0189 kg food/day /0.380 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Males and females tested, multigenerational study with 10 of each sex per group.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (mortality).
Q <sub>2</sub>	1	1	1	Long-term (2 year, 3 generation) study
Q <sub>3</sub>	1	1	1	NOAEL, atrophy of testes, decreased testes weight, decreased ovulation with higher doses
U	1	1	1	Multigenerational study, older evaluation endpoints
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	17.5	17.5	17.5	QCE = quantified critical endpoint
TRV	8.75	4.38	2.92	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	8.75	Test organism is in the same order and trophic level as the functional group members	none
2	4.38	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.92	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Butyl alcohol (n-Butanol) CAS 71-36-3

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Gavage

**Test Endpoint:** NOAEL

**Reference:** US EPA, 1986, *Butanol: Rat Oral Subchronic Toxicity Study*, Office of Solid Waste, Washington, DC.

**QCE:** 125 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers tested
Q <sub>1</sub>	1	1	1	Ecologically relevant
Q <sub>2</sub>	1	1	1	Chronic (92 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Well-designed experimental protocol
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	125	125	125	QCE = quantified critical endpoint
TRV	125	62.5	41.7	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	125	Test organism is in the same order and trophic level as the functional group members	None
2	62.5	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	41.7	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Butylbenzylphthalate (BBP) CAS 85-68-7

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** National Toxicology Program (NTP), 1985, *Twenty-six week subchronic study and modified mating trial in F344 rats, Butyl benyl phthalate*, Final Report, Project No. 12307-02-03, Hazelton Laboratories America, unpublished study, cited in IRIS.

**QCE:** 159 mg/kg-day

Adjustment Factors (AF)		Justification for adjustment factor		
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Only 15 males per group were tested. No females or juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Good overall design but no supporting studies of chronic duration available
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	159	159	159	QCE = quantified critical endpoint
TRV	13.3	6.63	4.42	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	13.3	Test organism is in the same order and trophic level as the functional group members	none
2	6.63	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	4.42	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Cadmium CAS 7440-43-9

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL Body weight gain, mortality

**Reference:** Pritzel, M.C., Y.H. Lie, E.W. Kienholz, and C.E. Whiteman, 1974, "The effect of dietary cadmium on the development of young chickens," *Poultry Science*, 53:2026-2029.

**QCE:** 29 mg/kg-day (400mg/kg)\*(0.011kg/day)/0.151 kg bw

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of males tested, 100
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant (growth, mortality).
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	3	3	3	LOAEL endpoint, but mortality observed
U	3	3	3	No reproductive endpoints examined, however, sensitive life stage examined. High doses tested. Presence of zinc in diet may have influenced (decreased) cadmium toxicity. NOAEL not identified.
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	29	29	29	QCE = quantified critical endpoint
TRV	0.81	0.40	0.27	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.81	Test organism is in the same order and trophic level as the functional group members	none
2	0.40	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.27	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\*Ingestion rate specified

\*\*BW estimated through the Rosomer article, 1961.

**COPC:** Cadmium CAS 7440-43-9

**Test Organisms:** Black Duck (Herbivore, Order-Anseriformes)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL

**Reference:** Heinz, G.H. and Haseltine, S.D., 1983, "Altered avoidance behavior of young black ducks fed cadmium," *Environ. Toxicol. Chem.*, 2:419-421, as cited in Eisler, 1985.

**QCE:** 0.14 mg/kg-day (4 mg/kg)\*(0.06 kg/day)/1.7 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers tested, males, females and juveniles given the doses.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (behavior).
Q <sub>2</sub>	1	1	1	Chronic (90-day) exposure
Q <sub>3</sub>	2	2	2	LOAEL endpoint
U	2	2	2	Reproductive endpoints and sensitive life stage examined, but only data given was on the flight response of the juveniles.
M	0.5	0.5	0.5	Cadmium chloride in the feed
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	0.14	0.14	0.14	QCE = quantified critical endpoint
TRV	0.07	0.04	0.2	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.07	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.04	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.02	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Cadmium CAS 7440-43-9

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL

**Reference:** Wills, J.H., Groblewski, G.E., Coulston, F., 1981, "Chronic and multigeneration toxicities of small concentrations of cadmium in the diet of rats," *Ecotoxicol. Environ. Safety*, 5:452-464.  
 ATSDR, Agency for Toxic Substance Disease Registry, 1989, *Toxicological Profile for Cadmium*, March, 1989.

**QCE:** 5.5 E-3 mg/kg-day Specified

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of males females and juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (growth, mortality).
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	2	2	2	LOAEL
U	1	1	1	Excellent design, four-generational study.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5.5E-3	5.5E-3	5.5E-3	QCE = quantified critical endpoint
TRV	3E-3	1E-3	8E-4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3E-3	Test organism is in the same order and trophic level as the functional group members	none
2	1E-3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	8E-4	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Carbon disulfide CAS 75-15-0

**Test Organisms:** Rabbit and rat (Herbivore, Order-Lagomorpha; Omnivore, Order-Rodentia)  
**Exposure Medium:** Inhalation  
**Test Endpoint:** NOAEL  
**Reference:** Hardin, B.D., et al., 1981, "Testing of selected workplace chemicals for teratogenic potential," *Scandinavian Journal of Work and Environmental Health*, 7(4):66-75.  
**QCE:** 11 mg/kg-day (62.3 mg/m<sup>3</sup>)\*(1.6m<sup>3</sup>/day)(6h/24h)(0.5 adsorption)/(1.13 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Low number (29) of female rats tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction).
Q <sub>2</sub>	2	2	2	Subchronic exposure
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Multispecies study that evaluated reproductive toxicological endpoints, such as reproduction. Supporting oral chronic toxicity studies are lacking, actual data not presented.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	11	11	11	QCE = quantified critical endpoint
TRV	0.92	0.46	0.31	Toxicity Reference Value = QCE/Total AF

R Value	TRV(mg/kg-day)	Justification	Appropriate Functional Group
1	0.92	Test organism is in the same order and trophic level as the functional group members	none
2	0.46	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.31	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

\*Data of inhalation, BW and adsorption acquired from IRIS.

**COPC:** Carbon disulfide CAS 75-15-0

**Test Organisms:** Rabbit (Herbivore, Order-Lagomorpha)

**Exposure Medium:** Inhalation

**Test Endpoint:** FEL

**Reference:** Jones-Price, C., et al., 1984, *Teratologic Evaluation of Carbon Disulfide (CAS# 75-15-0) Administered to New Zealand White Rabbits on Gestational Days 6-19*, Research Triangle Park, NC, National Center for Toxicological Research, Division of Teratogenesis Research, NCTR 222-80-2031(c) NTIS PB84-0192350.

**QCE:** 25 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Study exposure during critical life stages (gestation)
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	2	2	2	Subchronic exposure
Q <sub>3</sub>	3	3	3	FEL
U	2	2	2	Other studies indicate similar results. Sensitive species used.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	25	25	25	QCE = quantified critical endpoint
TRV	2.1	1.0	0.69	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.1	Test organism is in the same order and trophic level as the functional group members	none
2	1.0	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.69	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Carbon tetrachloride CAS 56-23-5

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Corn oil gavage

**Test Endpoint:** NOAEL Liver lesions

**Reference:** Bruckner, J.V., W.F. Mackenzie, S. Muralidhara, R. Luthra, G.M. Kyle, and D. Acosta, 1986, "Oral Toxicity of Carbon Tetrachloride; Acute, Subacute, and Subchronic Studies in Rats," *Fundamental and Applied Toxicology*, 6:16-34.

**QCE:** 0.71 mg/kg-day Dose adjusted for treatment schedule 1mg/kg-day\*5days fed/7 days

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers, but only males were tested. No females or juveniles tested (60 males)
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (liver lesions)
Q <sub>2</sub>	1	1	1	Chronic (12-week) study
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	No reproductive endpoints or sensitive life stage examined.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.71	0.71	0.71	QCE = quantified critical endpoint
TRV	0.18	0.09	0.06	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.18	Test organism is in the same order and trophic level as the functional group members	none
2	0.09	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.06	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322



**COPC:** Cerium chloride CAS 7790-86-5

**Test Organisms:** Rats (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** FEL

**Reference:** Environ. Qual. Safety Suppl., 1975, 1:1; RTECS

**QCE:** 2,111 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on sex, age, and number of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL
U	3	3	3	Limited information. No reproductive endpoint or sensitive life stage examined. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2,111	2,111	2,111	QCE = quantified critical endpoint
TRV	26.06	13.03	8.687	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	26.06	Test organism is in the same order and trophic level as the functional group members	none
2	13.03	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	8.687	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Chloride CAS 16887-00-6

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** FEL

**Reference:** Iyakuhin Kenkyu, 21:57, RTECS.

**QCE:** 714 mg/kg-day (from potassium chloride)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL
U	3	3	3	Limited information, no reproductive endpoints and sensitive life stage (offspring) examined. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	714	714	714	QCE = quantified critical endpoint
TRV	8.81	4.41	2.94	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	8.81	Test organism is in the same order and trophic level as the functional group members	none
2	4.41	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.94	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Chloroform CAS 67-66-3

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Gavage

**Test Endpoint:** NOAEL

**Reference:** Palmer, A.K. et al., 1979, "Safety evaluation of toothpaste containing chloroform II. Long-term studies in rats," *Journal of Environmental Pathology and Toxicology*, 2:821-833.

**QCE:** 150 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Groups of 50 cesarean-derived SPF Sprague-Dawley rats of each sex administered received the one dose.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoints (liver, kidney, gonads)
Q <sub>2</sub>	1	1	1	Long-term chronic study (94 weeks)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Depression of food consumption in females only. Four dose levels tested: 15, 30, 150, and 410 mg/kg-day.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	150	150	150	QCE = quantified critical endpoint
TRV	37.5	18.8	12.5	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	37.5	Test organism is in the same order and trophic level as the functional group members	none
2	18.8	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	12.5	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Chloroform CAS 67-66-3

**Test Organisms:** Beagle dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Diet (gelatin capsules)

**Test Endpoint:** NOAEL Liver effects

**Reference:** Heywood, R., R.J. Sortwell, P.R.B. Noel, et al., 1979, "Safety evaluation of toothpaste containing chloroform. III. Long-term study in beagle dogs," *Journal of Environmental Pathology and Toxicology*, 2:835-851.

**QCE:** 12.9 mg/kg-day 15 mg/kg-day was specified and the value was adjusted for the feeding schedule of 6 days/week.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Eight each males and females were tested. No juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (liver effects)
Q <sub>2</sub>	1	1	1	Chronic (7.5-year) study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Study used relatively small but adequate number of test animals and multiple endpoints were measured. Only two treatment doses were used and reproduction was poorly characterized.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	12.9	12.9	12.9	QCE = quantified critical endpoint
TRV	3.23	1.61	1.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3.23	Test organism is in the same order and trophic level as the functional group members	M422A
2	1.61	Test organism is in a different order and same trophic level from the functional group members	M422
3	1.08	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:** Chloroform CAS 67-66-3

**Test Organisms:** Rabbits (Herbivore, Order-Lagomorpha)

**Exposure Medium:** Gavage during gestation

**Test Endpoint:** LOAEL

**Reference:** Thompson, D.J., S.D. Warner, and V.B. Robinson, 1974, "Teratology studies on orally administered chloroform in the rat and rabbit," *Toxicology and Applied Pharmacology*, 29:348-357.

Ruddick, J.A., D.C. Villeneuve, I. Chu, and V.E. Valli, 1980, "Teratogenicity assessment of four halomethanes," *Teratology*, 21:66A, Abstract.

**QCE:** 20 mg/kg-day Specified

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers tested, but only female.
1	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	2	2	2	Short-term exposure during gestation only, but subchronic for development through the important stages
Q <sub>3</sub>	2	2	2	LOAEL endpoint
U	2	2	2	Good design, examined reproductive endpoints (fetus) and critical life stage. Only female adults were given the dosage.
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	20	20	20	QCE = quantified critical endpoint
TRV	1.3	0.63	0.42	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.3	Test organism is in the same order and trophic level as the functional group members	none
2	0.63	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.42	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Chloroform CAS 67-66-3

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Gavage during gestation

**Test Endpoint:** NOAEL

**Reference:** Thompson, D.J., S.D. Warner, and V.B. Robinson, 1974, "Teratology studies on orally administered chloroform in the rat and rabbit," *Toxicity and Applied Pharmacology*, 29:348-357.

**QCE:** 20 mg/kg-day Specified

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number of females given the dosage.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	2	2	2	Short-term exposure during gestation and most of the development period
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Good design, examined reproductive endpoints (fetus) and critical life stage, but a short term exposure
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	20	20	20	QCE = quantified critical endpoint
TRV	2.5	1.3	0.83	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.5	Test organism is in the same order and trophic level as the functional group members	none
2	1.3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.83	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Chromium(III) CAS 7440-47-3

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Ivankovic and Preussmann, 1975, "Absence of toxic and carcinogenic effects after administration of high doses of chromic oxide pigment in subacute and long-term feeding experiments in rats," *Food and Cosmetic Toxicology*, 13(3): 347-351.

**QCE:** 1500 mg/kg-day 1800 g/kg total dose consumed at highest dose rate, administered 5 days/week for 120 weeks (~840 days total), corrected for % Cr.

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity study with adequate numbers of animals
Q <sub>1</sub>	2	2	2	No endpoint affected (treatments had no effect on life expectancy, food consumption, growth rate, or cancer incidence).
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	1	1	1	Large chronic study
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1500	1500	1500	QCE = quantified critical endpoint
TRV	750	375	250	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	750	Test organism is in the same order and trophic level as the functional group members	none
2	375	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	250	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Chromium (III) CAS 7440-47-3

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Romoser, G.L., W.A. Dudley, L.J. Machlin, and L. Loveless, 1961, "Toxicity of vanadium and chromium for the growing chick," *Poultry Science*, 40:1171-1173.

**QCE:** 49 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Primary source unavailable
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (growth, mortality).
Q <sub>2</sub>	2	2	2	Subchronic exposure duration
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	3	3	3	Old study, limited endpoints
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	49	49	49	QCE = quantified critical endpoint
TRV	4.1	2.0	1.4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	4.1	Test organism is in the same order and trophic level as the functional group members	none
2	2.0	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	1.4	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:** Chromium (VI) CAS 7440-47-3

**Test Organisms:** Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Drinking water

**Test Endpoint:** NOAEL

**Reference:** Steven et al., 1976 cited in Eisler (1986)  
 Anwar, R.A., et al., 1961, "Chronic toxicity studies. Part III. Chronic toxicity of cadmium and chromium in dogs," *Archives of Environmental Health*, 3:456-460.  
 Steven, J.D. et al., 1976, *Effects of Chromium in the Canadian Environment*, RCC No. 15017, National Resources Council, Ottawa, Canada.

**QCE:** 0.30 mg/kg-day (11.2 mg/L)(3.1mL/100g-day)(8730g)(1L/1000mL)/8.73 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number of female dogs only. No males tested.
Q <sub>1</sub>	1	1	1	No endpoint observed
Q <sub>2</sub>	1	1	1	Chronic duration (4 years)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint studied, but good duration of testing.
M	0.5	0.5	0.5	Soluble salt placed in the drinking water.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	0.30	0.30	0.30	QCE = quantified critical endpoint
TRV	0.15	0.08	0.05	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.15	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.08	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.05	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:** Chromium(VI) CAS 7440-47-3

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Drinking water

**Test Endpoint:** FEL

**Reference:** Trivedi, B., et al., 1989, "Embryotoxicity and fetotoxicity of orally administered hexavalent chromium in mice," *Reproductive Toxicology*, 3(4):275-278.

**QCE:** 59 mg/kg-day Specified from 1.76 mg/mouse-day and a BW of 0.030 kg

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers, variability assessed appropriately and not high.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic exposure duration
Q <sub>3</sub>	3	3	3	FEL endpoint - fetal development harmed
U	2	2	2	Well designed study, appropriate endpoints well characterized, but no NOAEL identified.
M	0.5	0.5	0.5	Soluble salt placed in the drinking water
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	59	59	59	QCE = quantified critical endpoint
TRV	9.8	4.9	3.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	9.8	Test organism is in the same order and trophic level as the functional group members	none
2	4.9	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	3.3	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Chrysene CAS 218-01-9

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Dermal

**Test Endpoint:** LOAEL

**Reference:** Hecht, S.S., Bondinell, W.E., Hoffmann, D., 1974, "Chrysene and methylchrysenes: Presence in tobacco smoke and carcinogenicity," *J. Nat. Cancer Inst.*, 53:1121-1133.  
US Department of Health and Human Services, Public Health Service, Agency for Toxic Substances and Disease Registry, 1990, *Toxicological Profile for Chrysene*, March.

**QCE:** 1.2 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	20 female Swiss mice (Ha/ICR/Mil).
Q <sub>1</sub>	1	1	1	Endpoint of relevant ecological significance
Q <sub>2</sub>	1	1	1	Chronic (Applied 3 times weekly for 17 months)
Q <sub>3</sub>	2	2	2	LOAEL endpoint - benign and malignant skin tumors
U	3	3	3	Limited information supplied in ATSDR reference. No results of the control group or supporting data, dose estimated from topical application.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.2	1.2	1.2	QCE = quantified critical endpoint
TRV	0.10	0.05	0.03	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.10	Test organism is in the same order and trophic level as the functional group members	none
2	0.05	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.03	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Cobalt (cobalt chloride) CAS 7440-48-4

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)  
**Exposure Medium:** Diet  
**Test Endpoint:** LOAEL Increased mortality associated with *S. gallinarium* infection  
**Reference:** Hill, C.H., 1979, "The effect of dietary protein levels on mineral toxicity in chicks," *Journal of Nutrition*, 109:501-507.

**QCE:** 10.2 mg/kg-day 100 ppm in diet converted to dose using an ingestion rate\* of 0.02 kg/day and estimated body weight of 0.2kg from study.

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of animals, but variability not addressed.
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	No reproductive endpoints examined, but sensitive life stage evaluated
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	10.2	10.2	10.2	QCE = quantified critical endpoint
TRV	0.638	0.319	0.213	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.638	Test organism is in the same order and trophic level as the functional group members	none
2	0.319	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.213	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\* Estimated as 0.0582 Wt<sup>0.651</sup> (kg) as cited in EPA, 1993. Wildlife Exposure Factors Handbook.

**COPC:** Cobalt CAS 7440-48-4

**Test Organisms:** Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Brewer, B., 1940, "A statistical study of cobalt polycythemia in the dog," Am. J. Physiology, 128:345-348.  
Agency for Toxic Substance Disease Registry (ATSDR), 1990, *Draft: Toxicological Profile for Cobalt*, October.

**QCE:** 5.0 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only females tested, 7 total dogs.
Q <sub>1</sub>	0.1	0.1	0.1	Endpoint of unknown ecological significance
Q <sub>2</sub>	2	2	2	Subchronic duration (4 weeks)
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Older study, reasonable design, no reproductive endpoints or sensitive life stage examined.
Total AF	1.2	2.4	3.6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5.0	5.0	5.0	QCE = quantified critical endpoint
TRV	4.2	2.1	1.4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	4.2	Test organism is in the same order and trophic level as the functional group members	M422A
2	2.1	Test organism is in a different order and same trophic level from the functional group members	M422
3	1.4	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:** Cobalt CAS 7440-48-4

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Nation, J.R., Bourgeois, A.E., Clark, D.E. et al., 1983, "The effects of chronic cobalt exposure on behavior and metallothionein levels in the adult rat," *Neurobehav. Toxicol. and Teratology*, 5:9-15.  
Agency for Toxic Substance Disease Registry (ATSDR), 1990, *Draft: Toxicological Profile for Cobalt*, October.

**QCE:** 5.0 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Small number of male rats tested (18)
Q <sub>1</sub>	1	1	1	Endpoint of relevant ecological significance
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Reasonable study, but sensitive life stage not examined
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5.0	5.0	5.0	QCE = quantified critical endpoint
TRV	0.42	0.21	0.14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.42	Test organism is in the same order and trophic level as the functional group members	none
2	0.21	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.14	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** **Copper** CAS 7440-50-8

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Oral in diet (copper oxide)

**Test Endpoint:** NOAEL

**Reference:** Mehring, A.L., Jr., et al., 1960, "The tolerance of growing chicken for dietary copper," *Poultry Science*, 39:713-719.

**QCE:** 55.3 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Eleven dose levels during critical growth period, growth, mortality-for 10 weeks.
Q <sub>1</sub>	2	2	2	Ecologically relevant endpoint (mortality)
Q <sub>2</sub>	1	1	1	Chronic exposure duration
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	No reproductive endpoints examined, but sensitive life stages evaluated
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	55.3	55.3	55.3	QCE = quantified critical endpoint
TRV	13.8	6.91	4.61	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	13.8	Test organism is in the same order and trophic level as the functional group members	None
2	6.91	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	4.61	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:** Copper CAS 7440-50-8

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Stevenson, M.H., and N. Jackson, 1981, "An attempt to distinguish between the direct and indirect effects, in the laying domestic fowl, of added dietary sulfate," *British Journal of Nutrition*, 46(1):71-76.

**QCE:** 47 mg/kg-day (570mg/kg food)(44g food/day)(1kg/1000g)/0.534 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Rather small group sizes (n=6)
Q <sub>1</sub>	1	1	1	Endpoints are body weight, food intake, egg production, hepatic metals concentrations. Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic duration (10 weeks)
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Small group sizes, but detailed characterization of relevant endpoints.
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	47	47	47	QCE = quantified critical endpoint
TRV	7.83	3.92	2.61	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	7.83	Test organism is in the same order and trophic level as the functional group members	none
2	3.92	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	2.61	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\*Ingestion rate and body weight specified in article

**COPC:** Copper CAS 7440-50-8  
(as copper sulfate)

**Test Organisms:** Mink (Carnivore, Order-Carnivora)  
**Exposure Medium:** Diet  
**Test Endpoint:** NOAEL  
**Reference:** Aulerich, R.J., et al., 1982, "Effects of supplemental dietary copper on growth, reproductive performance and kit survival of standard dark mink and the acute toxicity of copper to mink," *Journal of Animal Science*, 55(2):337-43.

**QCE:** 11.71 mg/kg-day (85.5mg/kg food)(137g food/day)(1kg/1000g)/1 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Group sizes were small relative to observed variation in responses
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	1	1	1	Chronic exposure (357 days)
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Parameters observed were relevant but not exhaustive. Four doses tested: 25 (85.5 ppm total Cu), 50, 100, and 200 ppm.
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	11.71	11.71	11.71	QCE = quantified critical endpoint
TRV	1.95	0.98	0.65	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.95	Test organism is in the same order and trophic level as the functional group members	M322
2	0.98	Test organism is in a different order and same trophic level from the functional group members	none
3	0.65	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

**COPC:** Copper CAS 7440-50-8

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Hebert, C.D., et al., 1993, "Subchronic toxicity of cupric sulfate administered in drinking water and feed to rats and mice," *Fundamentals and Applied Toxicology*, 21:461-475.

**QCE:** 66 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Males appeared to be more sensitive than females, F334/N rats used
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic exposure
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Thorough and well-designed study, but subchronic duration prevented evaluation of long-term effects, e.g., development of tolerance as reported by others.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	66	66	66	QCE = quantified critical endpoint
TRV	5.5	2.8	1.8	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	5.5	Test organism is in the same order and trophic level as the functional group members	none
2	2.8	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	1.8	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Cyanide CAS 57-12-5

**Test Organisms:** European Starling (Insectivore, Order-Passeriformes)

**Exposure Medium:** Oral

**Test Endpoint:** LD<sub>50</sub>

**Reference:** Wiemeyer, S.N., et al., 1986, "Acute oral toxicity of sodium cyanide in birds," *Journal Wildlife Dis.*, 22:538-546.

**QCE:** 9.0 mg/kg 17mg NaCN/kgBW\*(26.02mg CN/49.01mg NaCN)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number of male and females tested
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant (lethality)
Q <sub>2</sub>	3	3	3	Acute study
Q <sub>3</sub>	3	3	3	LD <sub>50</sub>
U	3	3	3	Limited endpoint
Total AF	54	108	162	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	9.0	9.0	9.0	QCE = quantified critical endpoint
TRV	0.17	0.08	0.06	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.17	Test organism is in the same order and trophic level as the functional group members	AV210A
2	0.08	Test organism is in a different order and same trophic level from the functional group members	AV210, AV221, AV222, AV222A, AV232, AV233, AV241, AV242
3	0.06	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Cyanide CAS 57-12-5

**Test Organisms:** Mallard (Herbivore, Order-Anseriformes)

**Exposure Medium:** No vehicle indicated

**Test Endpoint:** LD<sub>50</sub>

**Reference:** E.F. Hill, Patuxent Wildlife Research Center, personal communication. As cited in Eisler, R., 1991, *Cyanide Hazards to Fish, Wildlife, and Invertebrates; A Synoptic Review*, U.S. Fish Wildlife Service Biological Report, 85(1.23):55p.

**QCE:** 1.43 mg/kg-day Specified

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source, number of animals not indicated
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant (lethality)
Q <sub>2</sub>	3	3	3	Acute study
Q <sub>3</sub>	3	3	3	Lethality endpoint
U	3	3	3	Limited information
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.43	1.43	1.43	QCE = quantified critical endpoint
TRV	0.018	0.009	0.006	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.018	Test organism is in the same order and trophic level	AV142, AV143
2	0.009	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.006	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Cyanide CAS 57-12-5

**Test Organisms:** Pig (Sows) (Omnivore, Order-Artiodactyla)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL

**Reference:** Tewe, O.O., and J.H. Maner, 1981, "Performance and pathophysiological changes in pregnant pigs fed Cassava diets containing different levels of cyanide," *Res. Veter. Science*, 30:147-151.

**QCE:** 9.5 mg/kg-day (520.7mg/kg Cassava)\*(3.1kg/day)/170.8kgBW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Limited number of animals, only females tested
Q <sub>1</sub>	0.5	0.5	0.5	Ecologically relevance questionable
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	2	2	2	LOAEL endpoint
U	2	2	2	Limited information, but sensitive life stage tested.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	9.5	9.5	9.5	QCE = quantified critical endpoint
TRV	0.79	0.39	0.26	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.79	Test organism is in the same order and trophic level as the functional group members	none
2	0.39	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.26	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M132, M210, M210A, M222, M322

**COPC:** Cyanide CAS 57-12-5

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Howard, J.W., and R.F. Hanzal, 1955, "Chronic toxicity for rats of food treated with hydrogen cyanide," *Journal Agric. Food Chem.*, 3:325-329.

US EPA, 1984, *Health Effect Assessment for Cyanides*, Office of Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH, for the Office of Emergency and Remedial Response, Washington, DC.

**QCE:** 10.8 mg/kg-day As specified in IRIS

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic study with adequate animals
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (growth)
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Two doses but no LOAEL identified, older study, but consistent with reproduction study results.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	10.8	10.8	10.8	QCE = quantified critical endpoint
TRV	5.40	2.70	1.80	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	5.40	Test organism is in the same order and trophic level as the functional group members	none
2	2.70	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	1.80	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Diethyl phthalate CAS 84-66-2

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** Brown, D., et al., 1978, "Short-term oral toxicity study of diethyl phthalate in the rat," *Food and Cosmetic Toxicology*, 16:415-422.

**QCE:** 750 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	CD rats (15/sex) evaluated. Additional groups of five rats/sex fed similar diets.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic (16-weeks) study
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Sufficient numbers of rats of both sexes employed and multiple endpoints studied.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	750	750	750	QCE = quantified critical endpoint
TRV	188	93.8	62.5	Toxicity Reference Value = QCE/Total AF

**Appropriate Functional Groups:**

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	188	Test organism is in the same order and trophic level as the functional group members	none
2	93.8	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	62.5	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Di-2-ethylhexyl-phthalate (DEHP) CAS 117-81-7

**Test Organisms:** Guinea Pig (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** LOAEL

**Reference:** Carpenter, C.P., C.S. Weil, and H.F. Smyth, 1953, "Chronic oral toxicity of di(2-ethylhexyl)phthalate for rats and guinea pigs and dogs," *Arch. Indust. Hyg. Occup. Med.*, 8:219-226.  
 Agency for Toxic Substances and Disease Registry, 1993, *Toxicological Profile for Di(2-Ethylhexyl) Phthalate*, US Department of Commerce, National Technical Information Series, April.

**QCE:** 19 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Males and females tested. No juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Long-term (1-year) study
Q <sub>3</sub>	2	2	2	LOAEL endpoint
U	2	2	2	Sufficient numbers of guinea pigs used and study measured multiple endpoints. Only two concentrations of DEHP tested. Corroborating chronic animal bioassays exist.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	19	19	19	QCE = quantified critical endpoint
TRV	2.4	1.2	0.79	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.4	Test organism is in the same order and trophic level as the functional group members	none
2	1.2	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.79	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Di-n-butylphthalate CAS 84-74-2

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** Smith, C.C., 1953, "Toxicity of butyl stearate, dibutyl sebacate, dibutyl phthalate, and methoxyethyl oleate," *Archives of Hygiene and Occupational Medicine*, 7:310-318.

**QCE:** 125 mg/kg-day

	Adjustment Factors (AF)			Justification for adjustment factor
	R	I	U	
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Only one sex tested. No juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Long-term (1-year) study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	3	3	3	No histopathologic evaluation reported. Existence of other subchronic studies to support the critical effect and the magnitude of the LOAEL are not available. Not clear if effects observed at higher treatment doses were dose-related.
Total AF	9	18	27	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	125	125	125	QCE = quantified critical endpoint
TRV	13.9	6.94	4.63	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	13.9	Test organism is in the same order and trophic level as the functional group members	none
2	6.94	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	4.63	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Di-n-octylphthalate CAS 117-84-0

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL

**Reference:** Piekacz, H., 1971, "Effect of dioctyl and dibutyl phthalates on the organisms of rats after oral administration in prolonged experiment. II. Subacute and chronic toxicity," *Rocz. Panstw. Zakl. Hig.*, 22(3):295-307. \*

**QCE:** 174 mg/kg-day (3500mg/kg food)\*(0.0189kg food/day)/0.38kgBW

	Adjustment Factors (AF)			Justification for adjustment factor
	R	I	Q	
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	100 rats (20/dose) male and females tested
Q <sub>1</sub>	0.5	0.5	0.5	Ecological relevance questionable (liver and kidney weights)
Q <sub>2</sub>	1	1	1	Chronic duration
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Good design, but no reproductive endpoints evaluated.
Total AF	4	8	12	R * I * Q <sub>1</sub> * Q <sub>2</sub> * Q <sub>3</sub> * U = Total AF
QCE (mg/kg-day)	174	174	174	QCE = quantified critical endpoint
TRV	43.5	21.8	14.5	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	43.5	Test organism is in the same order and trophic level as the functional group members	none
2	21.8	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	14.5	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\*Entire article is in Polish-there is a summary on the last page in English

**COPC:** Ethanol (Ethyl alcohol) CAS 64-17-5

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** AEL

**Reference:** Cadete-Leite A. et al., 1989, "Hippocampal mossy fiber-CA3 synapses after chronic alcohol consumption and withdrawal," *Alcohol*, 6(4):303-310, Washington, DC.

**QCE:** 9,000 mg/kg-day Specified

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers tested, but only males.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic study (three test groups of 6, 12 and 18 months were tested)
Q <sub>3</sub>	3	3	3	AEL endpoint
U	2	2	2	No NOAEL established and nonreproductive endpoints were studied.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	9,000	9,000	9,000	QCE = quantified critical endpoint
TRV	750	375	250	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	750	Test organism is in the same order and trophic level as the functional group members	None
2	375	Test organism is in a different order and same trophic level from the functional group members	M121, M123, M422, M422A
3	250	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

**COPC:** Ethanol (Ethyl Alcohol) CAS 64-17-5

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Gavage

**Test Endpoint:** LOAEL

**Reference:** Mankes, R.F., et al., 1982, "Teratogenic and reproductive effects of ethanol in Long-Evans rats," *J. of Toxicol. Environ. Health*, 10:267-276.

**QCE:** 31.9 mg/kg-day [0.4 mL Ethanol/kg BW \* 0.798 g. Ethanol/mL Ethanol \* 100mg/1 g] = 31.9 mg/kg-day.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Administered through a critical life stage (gestation)
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	2	2	2	LOAEL endpoint
U	2	2	2	Two doses, 0.4 ml Ethanol/kg-day had no effect on most reproductive parameters, the incidence of malformed fetuses was significantly increased at the 4.0 dose level.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	31.9	31.9	31.9	QCE = quantified critical endpoint
TRV	7.98	3.99	2.66	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	7.98	Test organism is in the same order and trophic level as the functional group members	None
2	3.99	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.66	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Ethylbenzene CAS100-41-4

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (olive oil)

**Test Endpoint:** LOAEL

**Reference:** Wolfe, M.A., et al., 1956, "Toxicological studies of certain alkylated benzenes and benzene," *Archives of Industrial Health*, 14:387-398.

**QCE:** 408 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only 10 female/treatment group tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic (182-day) study
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Only one sex tested. Not clear if effects observed at higher treatment doses were dose-related.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	408	408	408	QCE = quantified critical endpoint
TRV	51.0	25.5	17.0	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	51.0	Test organism is in the same order and trophic level as the functional group members	none
2	25.5	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	17.0	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Fluoranthene CAS 206-44-0

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** NOAEL

**Reference:** EPA, 1988, *13-Week mouse oral subchronic toxicity study*, Prepared by Toxicity Research Laboratories, Ltd., Muskegon, MI for the Office of Solid Waste, Washington, DC.

**QCE:** 125 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	20 each sex/treatment group evaluated.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic (13-week) study
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Well-designed study that identified both a LOAEL and a NOAEL for several sensitive endpoints using an adequate number of animals. Supporting chronic toxicity and reproductive studies are lacking.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	125	125	125	QCE = quantified critical endpoint
TRV	31.3	15.6	10.4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	31.3	Test organism is in the same order and trophic level as the functional group members	none
2	15.6	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	10.4	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Fluorene CAS 86-73-7

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (corn oil gavage)

**Test Endpoint:** LOAEL

**Reference:** EPA, 1989, *Mouse Oral Subchronic Study with Fluorene*, Study conducted by Hazleton Laboratories Inc. for the Office of Solid Waste, Washington, DC.

**QCE:** 250 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	25 each sex/treatment group evaluated. No juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (blood chemistry)
Q <sub>2</sub>	1	1	1	Chronic (13-week) study
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Numerous endpoints measured. Adequate number of animals tested. Supporting chronic toxicity and reproductive studies are lacking.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	250	250	250	QCE = quantified critical endpoint
TRV	31.3	15.6	10.4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	31.3	Test organism is in the same order and trophic level as the functional group members	none
2	15.6	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	10.4	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Fluoride CAS 16984-48-8

**Test Organisms:** Mink (Carnivore, Order-Carnivora)

**Exposure Medium:** Oral in diet (NaF)

**Test Endpoint:** NOAEL

**Reference:** Aulerich, R.J., et al., 1987, "Chronic toxicity of dietary fluorine in mink," *Journal of Animal Science*, 65:1759-1767.

**QCE:** 31.4 mg/kg-day (229mg/kg-day)\*(0.137kg/day)/1kg BW

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of males and females (60 each) tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic (382-days)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Good design, looked at sensitive life stages and reproduction
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	31.4	31.4	31.4	QCE = quantified critical endpoint
TRV	31.4	15.7	10.5	Toxicity Reference Value = QCE/Total AF

	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	31.4	Test organism is in the same order and trophic level as the functional group members	M322
2	15.7	Test organism is in a different order and same trophic level from the functional group members	none
3	10.5	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

**COPC:** Fluoride CAS 16984-48-8

**Test Organisms:** Screech Owl (Carnivore, Order-Strigiformes)

**Exposure Medium:** Oral in diet (NaF)

**Test Endpoint:** NOAEL

**Reference:** Patte, O.H., S.N. Wiemeyer, D.M. Swienford, 1988, "Effects of dietary fluoride on reproduction in eastern screech owls," *Archives of Environmental Contamination and Toxicology*, 17:213-218.

**QCE:** 7.8 mg/kg-day (56.5 mg/kg food)\*(0.025kg/day)/0.181kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of animals (33 males and 33 females)
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic (5-6 months)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Good design, the study exposure included critical life stage, but only two dose levels.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	7.8	7.8	7.8	QCE = quantified critical endpoint
TRV	3.9	2.0	1.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3.9	Test organism is in the same order and trophic level as the functional group members	none
2	2.0	Test organism is in a different order and same trophic level from the functional group members	AV310, AV322, AV333, AV342
3	1.3	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV422, AV432, AV433, AV442

\*\*B.W from Dunning, 1984.

\*\*\*Diet consumption from 1500g/pair/month from study.

**COPC:** Formaldehyde CAS 50-00-0

**Test Organisms:** Beagle Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Hurni, H. and H. Ohder, 1973, "Reproduction study with formaldehyde and hexamethylenetetramine in beagle dogs," *Food and Cosmetic Toxicology*, 11:459-462.

**QCE:** 9.4 mg/kg-day Specified

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only 51 females were given the doses, but effects on juveniles were studied
Q <sub>1</sub>	1	1	1	Ecological relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic study (days 4-56 of gestation).
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Good study, reproductive endpoints tested
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	9.4	9.4	9.4	QCE = quantified critical endpoint
TRV	2.4	1.2	0.78	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.4	Test organism is in the same order and trophic level as the functional group members	M422A
2	1.2	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.78	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:** Formaldehyde CAS 50-00-0

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (drinking water)

**Test Endpoint:** NOAEL

**Reference:** Til, H.P., et al., 1989, "Two-year drinking water study of formaldehyde in rats," *Food Chemical Toxicology*, 27:77-87.

**QCE:** 15 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	140 males and females tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic study (2 years).
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	High quality study, four dosing groups, but no reproductive endpoints examined.
M	0.5	0.5	0.5	Placed in drinking water.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	15	15	15	QCE = quantified critical endpoint
TRV	15	7.5	5.0	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	15	Test organism is in the same order and trophic level as the functional group members	none
2	7.5	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	5.0	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Hexachlorobenzene CAS 319-85-7

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** Grant, D.L., Phillips, W.E.J. and G.V. Hatina, 1977, "Effect of hexachlorobenzene on reproduction in the rat," *Archives of Environmental Contamination and Toxicology*, 5(2):207-216.

**QCE:** 20 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	4 generation reproductive study
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoints
Q <sub>2</sub>	1	1	1	Chronic
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Good study design, supporting articles
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	20	20	20	QCE = quantified critical endpoint
TRV	20	10	6.7	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	20	Test organism is in the same order and trophic level as the functional group members	none
2	10	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	6.7	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Hexachlorobenzene CAS 319-85-7

**Test Organisms:** Mink (Carnivore, Order-Carnivora)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Bleavins, M.R., Aulerich, R.J. and R.K. Ringer, 1984, "Effects of chronic dietary hexachlorobenzene exposure on the reproductive performance and survivability of mink and European ferrets," *Archives of Environmental Contamination and Toxicology*, 13:357-365.

**QCE:** 1 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	78 adult mink divided into 5 treatment groups and one control group (each containing 10 females 3 males). Doses 0 (control), 1, 5, 25, 125, 625 mg/kg.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic (331 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Reproduction was looked at, no mink whelped at 125 mg/kg and no mink survived the 625 mg/kg dose through the breeding season.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1	1	1	QCE = quantified critical endpoint
TRV	1	0.5	0.33	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1	Test organism is in the same order and trophic level as the functional group members	M322
2	0.5	Test organism is in a different order and same trophic level from the functional group members	none
3	0.33	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

**COPC:** Hexachlorocyclohexane (*b*-Isomer) CAS 319-85-7

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** Van Velsen, F.L. et al., 1986, "The subchronic oral toxicity of the *b*-isomer of hexachlorocyclohexane in rats," *Fundamental and Applied Toxicology*, 6: 697-712.

**QCE:** 10 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Weanling SPF-derived Wistar Riv:TOX rats (10 males and 10 females in each group, 1 control and 4 dose groups) were given doses of 0, 2, 10, 50, or 250 mg/kg
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoints (growth, food intake, biochemistry, hematology, organ weights, and histopathology)
Q <sub>2</sub>	1	1	1	Chronic (13-weeks)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Used 10mg/kg and others based on tests done in 1950 by Fitzhugh et al.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	10	10	10	QCE = quantified critical endpoint
TRV	10	5.0	3.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	10	Test organism is in the same order and trophic level as the functional group members	none
2	5.0	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	3.3	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Hydrazine/hydrazine sulfate CAS 302-01-2

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Gavage

**Test Endpoint:** NOAEL

**Reference:** Biancifiori, C., 1970, "Hepatomas in CBA/Cb/Se mice and liver lesions in golden hamsters induced by hydrazine sulfate," *Journal National Cancer Institute*, 44:943-953.

**QCE:** 5.6 mg/kg-day (Specified) (0.14 mg/day)/0.025 kgBW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Around 200 males and females tested, no juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic study (25 weeks)
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Multiple dose with liver carcinomas induced in a dose-related manner in both sexes and lung metastases in some of the mice treated as the highest dose (1.13 mg/kg-day). No reproductive endpoints or sensitive life stages examined.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5.6	5.6	5.6	QCE = quantified critical endpoint
TRV	2.8	1.4	0.93	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.8	Test organism is in the same order and trophic level as the functional group members	none
2	1.4	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.93	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Hydrofluoric acid CAS 7664-39-3

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Inhalation

**Test Endpoint:** FEL

**Reference:** Wohlslagel, J., Dipasquale, L., Vernot, E., 1976, "Toxicity of solid rocket motor exhaust: Effects of HC, HF, and alumina on rodents," *J. Combust. Toxicol.*, 3:61.

**QCE:** 263 ppm

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers (50) of animals tested, but no males or juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Acute (one hour) exposure
Q <sub>3</sub>	3	3	3	FEL
U	3	3	3	Limited information. No reproductive endpoint or sensitive life stage examined. No NOAEL established. Test organisms exposed via inhalation versus diet.
Total AF	54	108	162	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (ppm)	263	263	263	QCE = quantified critical endpoint
TRV	4.87	2.44	1.62	Toxicity Reference Value = QCE/Total AF

R Value	TRV (ppm)	Justification	Appropriate Functional Group
1	4.87	Test organism is in the same order and trophic level as the functional group members	none
2	2.44	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	1.62	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Hydrofluoric Acid CAS 7664-39-3

**Test Organisms:** Rat (Omnivore, Order-Rodentia)  
**Exposure Medium:** Inhalation  
**Test Endpoint:** AEL  
**Reference:** Gig. Tr. Prof. Zarbol., 1975, 19(3):57; RTECS  
**QCE:** 470 ppm

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Secondary source so information on age and number of animals tested unknown. Pregnant females tested
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Four-hour exposure days 1 through 22 of pregnancy.
Q <sub>3</sub>	3	3	3	AEL-Adverse effects on fertility were observed, including pre- and post- implantation mortality
U	3	3	3	Limited information. Reproductive endpoint examined. No NOAEL established. Test organisms exposed via inhalation versus diet.
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	470	470	470	QCE = quantified critical endpoint
TRV	13.1	6.53	4.35	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	13.1	Test organism is in the same order and trophic level as the functional group members	none
2	6.53	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	4.35	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Lead CAS 7439-92-1

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet as lead acetate

**Test Endpoint:** NOAEL

**Reference:** Azar, A., H.J. Trochimowicz, M.E. Maxfield, 1973, "Review of lead studies in animals carried out at Haskell Laboratory: Two-year feeding study and response to hemorrhage study," in: *Environmental Health Aspects of Lead: Proceedings, International Symposium*, D. Barth et al., (ed.), Commission of European Communities, pp. 199-210.

**QCE:** 8.0 mg/kg-day (100 mg/kg food)\*(.028 kg/day)/0.35 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	50 male and 50 female rats per dose level. Reproductive three generation (during critical life stage) study.
Q <sub>1</sub>	1	1	1	Mortality, # of tumors, weight gain, # of pregnancies, # of pups born alive, fertility index, gestation index, viability index or lactation index. Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Pb as lead acetate was fed for a three-generation six-litter study at multiple dosages (0, 10, 50, 100, 1000, 2000 ppm). At 1000 and 2000 ppm dietary Pb, the average weight of weanling rats was slightly decreased. At 10 ppm stippled cells were increased. A decrease in ALAD activity was seen at 50 ppm (however these are not considered adverse effects). 100 ppm Pb is considered the NOAEL.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	8.0	8.0	8.0	QCE = quantified critical endpoint
TRV	8.0	4.0	2.7	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	8.0	Test organism is in the same order and trophic level as the functional group members	None
2	4.0	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.7	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\* Wiseman, J., 1987, "Feeding of Non-ruminant Livestock," Butterworths; Boston, MA.

**COPC:** Lead CAS 7439-92-1

**Test Organisms:** Beagle Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Diet as lead acetate

**Test Endpoint:** NOAEL

**Reference:** Azar, A., H.J. Trochimowicz, M.E. Maxfield, 1973, "Review of lead studies in animals carried out at Haskell Laboratory: Two-year feeding study and response to hemorrhage study," in: *Environmental Health Aspects of Lead: Proceedings, International Symposium*, D. Barth et al., (ed.), Commission of European Communities, pp. 199-210.

**QCE:** 13 mg/kg-day (500 mg/kg food)\*(0.24kg/day)/9.41 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Four male and four female beagle dogs were used at each dose level (0, 10, 50, 100 and 500 ppm). Two year study. Average variability.
Q <sub>1</sub>	1	1	1	Food consumption, growth, mortality, blood level and behavior. Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	There was no significant effects on appearance, behavior, weight gain, mortality, or neurologic examination of dogs to 500 ppm. A decrease in ALAD activity was seen at 100 ppm. Further study concluded that while ALAD is essential to the synthesis of hemoglobin, the amount needed is but a small fraction of that normally present and this is not an adverse effect. Lack of reproductive endpoint.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	13	13	13	QCE = quantified critical endpoint
TRV	3.3	1.6	0.81	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3.3	Test organism is in the same order and trophic level as the functional group members	M422A
2	1.6	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.81	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\*ingestion rate and BW taken from data table for animals

**COPC:** Lead CAS 7439-92-1

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Eisler, R., 1988, *Lead Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, Fish and Wildlife Service. Bio. Rep. No. 14, April, 1985.

**QCE:** 26 mg/kg-day                      500 mg/kg in diet converted to dose by multiplying by 0.105 kg/day ingestion rate and dividing by 2 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant (growth)
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	3	3	3	Limited information. Dietary NOAEL appears consistent for a variety of species.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	26	26	26	QCE = quantified critical endpoint
TRV	1.4	0.72	0.48	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.4	Test organism is in the same order and trophic level as the functional group members	none
2	0.72	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.48	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:****Lead CAS 7439-92-1****Test Organisms:**

Bovine (Herbivore, Order-Artiodactyla)

**Exposure Medium:**

Diet (in hay and grain)

**Test Endpoint:**

LD50

**Reference:**Zmudski, J., et al., 1983, "Lead poisoning in cattle: Reassessment of the minimum toxic oral dose," *Bulletin of Environmental Contamination*, 30:435-441.**QCE:**

2.7 mg/kg-day

Specified

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	22 Holstein males (9-12 weeks old) weighing approx. 55 kg. were tested
Q <sub>1</sub>	1	1	1	Lethality
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	3	3	3	Lethality endpoint, death w/in 20 days if on milk diet
U	3	3	3	Reasonable design however, pregnant ewes given 3 mg/kg (species sensitivity could be $\geq$ ) daily did not produce adverse effects (DeMayo, et. al., 1982).
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.7	2.7	2.7	QCE = quantified critical endpoint
TRV	0.075	0.038	0.025	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.075	Test organism is in the same order and trophic level as the functional group members	none
2	0.038	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.025	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Lead CAS 7439-92-1

**Test Organisms:** Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Diet

**Test Endpoint:** FEL Chronic toxic level

**Reference:** DeMayo, A., et al., 1982, "Toxic effects of lead and lead compounds on human health, aquatic life, wildlife, plants, and livestock," *CRC Crit. Rev. Environ. Control*, 12:257-305.  
 Rice, D.C., 1985, "Chronic low-lead exposure from birth produces deficits in discrimination reversal in monkeys," *Toxicology and Applied Pharmacology*, 77:201-210.

**QCE:** 0.32 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Tertiary source - cites a textbook
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (growth, mortality)
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	3	3	3	FEL
U	2	2	2	Limited information. However, a chronic study in monkeys reported a similar LOAEL (0.1 mg/kg/day) for CNS effects (Rice, 1985).
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.32	0.32	0.32	QCE = quantified critical endpoint
TRV	0.018	0.009	0.006	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.018	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.009	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.006	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:** Lead CAS 7439-92-1

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Drinking Water (Pb as lead acetate)

**Test Endpoint:** NOAEL

**Reference:** Kimmel, C.A., et al., 1980, "Chronic low-level lead toxicity in the rat. I. Maternal toxicity and perinatal effects," *Toxicol. Appl. Pharmacology*, 56:28-41.

**QCE:** 0.36 mg/kg-day Specified (5 mg/l in water, rat water intake .025 L/day/0.35 kg BW).

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	#'s of animals in control and Pb groups ranged from 60 to 148 during the pregnancy period (2 generations), from 24 to 75 pre-pregnancy, and 6 to 13 litters during post pregnancy. However, significant variation between replicates was seen, and only females (parental generation) examined.
Q <sub>1</sub>	1	1	1	Food % water consumption, reproductive success, and concentrations in selected tissue. Ecologically relevant endpoints.
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL (although Pb concentrations in blood were increased in females exposed to 5 ppm, toxicity was not seen at this level)
U	1	1	1	Good design, studied reproductive effects. Weanling female rats were exposed through mating, gestation and lactation (offspring then chronically). Various dose levels (0, 5, 25, 50 ppm) studied and NOAEL established. Other studies support findings. (DeMayo et al., 1982).
M	0.5	0.5	0.5	Lead acetate placed in drinking water.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.36	0.36	0.36	QCE = quantified critical endpoint
TRV	0.36	0.18	0.12	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.36	Test organism is in the same order and trophic level as the functional group members	none
2	0.18	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.12	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

DeMayo, A., et al., 1982, *Toxic Effects of Lead and Lead Compounds on Human Health, Aquatic Life, Wildlife, Plants, and Livestock*, CRC Crit. Rev. Environ. Control 12:257-305.

**COPC:** **Lead (Trimethyllead) CAS 7439-92-1**

**Test Organisms:** European Starling (Insectivore, Order-Passeriformes)  
**Exposure Medium:** Capsule  
**Test Endpoint:** LOAEL  
**Reference:** Osborn, D., W.J. Eney, and K.R. Bull, 1983, "The toxicity of trialkyl lead compounds to birds," *Environ. Pollut.*, 31A:261-275, as cited in Eisler, 1987.  
**QCE:** 2.8 mg/kg-day (0.2 mg/day)/0.070 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	6 birds/ group, sex not specified
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant (behavioral effects)
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	2	2	2	LOAEL
U	3	3	3	Limited information: organoform of lead could impact toxicity
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.8	2.8	2.8	QCE = quantified critical endpoint
TRV	0.08	0.04	0.03	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.08	Test organism is in the same order and trophic level as the functional group members	AV210A
2	0.04	Test organism is in a different order and same trophic level from the functional group members	AV210, AV221, AV222, AV222A, AV232, AV233, AV241, AV242
3	0.03	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Magnesium CAS 7439-95-4

**Test Organisms:** Sheep (Herbivore, Order-Artiodactyla)

**Exposure Medium:** Oral in drinking water

**Test Endpoint:** NOAEL

**Reference:** Pierce, A.W., 1959, "Studies on salt tolerance of sheep. II. The tolerance of sheep for mixtures of sodium chloride and magnesium chloride in the drinking water," *Australian Journal of Agricultural Research*, 10:725.

**QCE:** 13 mg/kg-day 700mg/day (0.05% MgCl dose)/55 kg BW\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	42 3-6 year old animals tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (loss of weight)
Q <sub>2</sub>	1	1	1	Chronic exposure (16 months).
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	No reproductive endpoint or sensitive life stage examined. Test organisms exposed to MgCl.
M	0.5	0.5	0.5	Magnesium chloride placed in drinking water
Total AF	1.5	3.0	4.5	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	13	13	13	QCE = quantified critical endpoint
TRV	8.7	4.3	2.9	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	8.7	Test organism is in the same order and trophic level as the functional group members	none
2	4.3	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	2.9	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

\*Magnesium intake and BW specified in article

**COPC:** Manganese CAS 7439-96-5

**Test Organisms:** Japanese Quail (Omnivore, Order-Galliformes)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Laskey, J.W. and F.W. Edens, 1985, "Effects of chronic high-level manganese exposure on male behavior in the Japanese quail (*Coturnix coturnix japonica*)," *Poultry Science*, 64: 579-584.

**QCE:** 575 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Only one dose administered (5000 ppm supplemented Mn plus 56 ppm Mn in base diet), no mention of the number of birds tested
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (growth, behavior)
Q <sub>2</sub>	1	1	1	Chronic (75 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Certain amount of food lost by birds eating behavior led to a wide range of food intake, no evidence to suggest altered locomotion as in previous studies
Total AF	9	18	27	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	575	575	575	QCE = quantified critical endpoint
TRV	63.9	31.9	21.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	63.9	Test organism is in the same order and trophic level as the functional group members	none
2	81.9	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	21.3	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:** Manganese CAS 7439-96-5

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Leeson, S., and J.D. Summers, 1982, *Effect of High Dietary Levels of Supplemental Zinc, Manganese, Copper, or Iron on Broiler Performance to Three Weeks of Age and Accumulation of These Minerals in Tissue and Excreta*, Nutrition Reports Int., 591-599.  
 Offiong, S.A., and S.M. Abed, 1980, "Fertility, hatchability and malformations in guinea fowl embryos as affected by dietary manganese," *British Poultry Science*, 21:371-375.

**QCE:** 1260 mg/kg-day (880 mg/kg food)\*(0.717 kg food/day-bird)\*(1 bird/0.5kg)\*\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate number of animals, limited variability
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (growth and reproduction)
Q <sub>2</sub>	3	3	3	Acute 13-day study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Only poultry production-type endpoints were evaluated
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1260	1260	1260	QCE = quantified critical endpoint
TRV	210	105	70.0	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	210	Test organism is in the same order and trophic level as the functional group members	none
2	105	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	70.0	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\*\* Ingestion rate and BW specified in Table II of the Leeson article.

**COPC:****Manganese CAS 7439-96-5****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

**Exposure Medium:**

Diet

**Test Endpoint:**

NOAEL

**Reference:**

Laskey, J.W., Rehnberg, G. L., and Hein, J.F., 1982, "Effects of chronic manganese (MN<sub>3</sub>O<sub>4</sub>) exposure on selected reproductive parameters in rats," *J. Toxicol. Environ. Health*, 9: 677-687.

ATSDR, Agency for Toxic Substance Disease Registry, 1990, *Draft: Toxicological Profile for Manganese*.

**QCE:**

88 mg/kg-day                      1100mg/kg food\*0.028kg/day/0.35kgBW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers, males, females and juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (decreased testosterone levels, delayed maturation of reproductive function).
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	1	1	1	Good design, reproductive endpoints examined and the study results consistent in mice.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	88	88	88	QCE = quantified critical endpoint
TRV	88	44	29	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	88	Test organism is in the same order and trophic level as the functional group members	none
2	44	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	29	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Mercury (Organic) CAS 7439-97-6

**Test Organisms:** Bovine (Herbivore, Order-Artiodactyla)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Herigstad, R.R., et al., 1972, "Chronic methylmercury toxicosis in calves," *J. Am. Vet. Med. Assoc.*, 160:173-182, (cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals, Washington, DC).

**QCE:** 0.1 mg/kg. body weight-day (Hg as methylmercury)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Discussion found that the results were similar to other reported studies. However, limited number of animals, impossible to evaluate variability, only one animal per dose.
Q <sub>1</sub>	1	1	1	Clinical signs, lesions, and tissue residues determined (associated with methyl mercury toxicity (MMT) in calves). Endpoint relevant.
Q <sub>2</sub>	1	1	1	Chronic exposure (96 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Small number of animals, 5 male Holstein-Friesian calves. No reproductive endpoint or sensitive life stage examined. Test chemical is methylmercury. NOAEL & LOAEL established. However only 1 animal per level tested.
Total AF	9	18	27	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.1	0.1	0.1	QCE = quantified critical endpoint
TRV	0.01	0.006	0.004	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.01	Test organism is in the same order and trophic level as the functional group members	none
2	0.006	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.004	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Mercury (Organic) CAS 7439-97-6

**Test Organisms:** American black duck (Herbivore, Order-Anseriformes, *Anas rubripes*)

**Exposure Medium:** Oral in diet (mash)

**Test Endpoint:** Adverse effect level

**Reference:** Finley, M.T. and R.C. Stendell, 1978, "Survival and reproductive success of black ducks fed methylmercury," *Environmental Pollution*, 16:51-64.

**QCE:** 0.169 mg/kg-day (3 ppm Hg fed as methylmercury dicyandiamide)  
(3mg/kg food \* 0.062 kg food/day)/(1.1 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Variability appears average.
Q <sub>1</sub>	1	1	1	Clutch size, egg production, # of eggs incubated, hatchability and survival of ducklings.
Q <sub>2</sub>	1	1	1	Chronic exposure (28 weeks)
Q <sub>3</sub>	3	3	3	Adverse effect level (reduced reproduction success)
U	3	3	3	No NOAEL established and only 1 dose level and control. 13 pairs of 1 year old ducks in each group, juveniles also tested.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.169	0.169	0.169	QCE = quantified critical endpoint
TRV	0.0094	0.0047	0.0031	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.0094	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.0047	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.0031	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

BW is taken as the mean for females (1.1 kg) from the CRC Handbook of Avian Body Masses (Dunning, 1993) allometric equations from Nagy (1987)  $FI = 0.648 BW^{0.651} = 0.062 \text{ kg/day}$

**COPC:**

**Mercury (Organic) CAS 7439-97-6**

**Test Organisms:**

Mallard Duck (Herbivore, Order-Anseriformes, *Anas platyrhynchos*)

**Exposure Medium:**

Oral in diet

**Test Endpoint:**

LOAEL

**Reference:**

Heinz, G. H., 1979, "Methyl mercury: reproductive and behavioral effects on three generations of mallard ducks," *Journal Wildl. Mgmt.*, 43:394-401.

**QCE:**

0.064 mg/kg-day (0.5mg/kg food)(128g food/day)(1kg/1000g)/1 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only one dose level, however, this was a three generation study that showed significant effects from control.
Q <sub>1</sub>	1	1	1	Endpoints include reproductive endpoints (i.e. # of eggs and hatchlings). Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic
Q <sub>3</sub>	2	2	2	LOAEL - one dose only
U	2	2	2	3 generations (>1 yr. and during a critical life stage) and reproductive endpoints examined. However, only 1 dose considered.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.064	0.064	0.064	QCE = quantified critical endpoint
TRV	0.008	0.004	0.003	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.008	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.004	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.003	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Mercury (Organic) CAS 7439-97-6

**Test Organisms:** Mule Deer (Herbivore, Order-Artiodactyla)

**Exposure Medium:** Single dose

**Test Endpoint:** FEL (LD<sub>50</sub>)

**Reference:** Eisler, R., 1987, *Mercury Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish and Wildlife Service Biological Report, 85(1.10).

**QCE:** 18 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	From secondary source, no other information
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Acute study
Q <sub>3</sub>	3	3	3	LD <sub>50</sub>
U	3	3	3	Secondary source, little supporting information
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	18	18	18	QCE = quantified critical endpoint
TRV	0.22	0.11	0.07	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.22	Test organism is in the same order and trophic level as the functional group members	None
2	0.11	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.07	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Mercury (Organic) CAS 7439-97-6

**Test Organisms:** Pheasants (Omnivore, Order-Galliformes)

**Exposure Medium:** Gelatin capsule

**Test Endpoint:** AEL

**Reference:** McEwen, L.C., et al., 1973, *Mercury-Wildlife Studies by the Denver Wildlife Research Center*, In *Mercury in the Western Environment*, D.R. Buhler, Ed., Oregon State University, Corvallis, OR, p. 146-156.

**QCE:** 0.64 mg/kg-day                      20 mg/kg Ceresan M<sup>R</sup> (mercury fungicide) the 0.64 mg/kg-day was specified by article for a 1 kg bird

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Not a large sample, three male and female pheasant pairs.
Q <sub>1</sub>	1	1	1	Endpoints included the # of eggs laid, fertile, hatched and alive chicks. Ecologically relevant endpoint.
Q <sub>2</sub>	2	2	2	Subchronic exposure (30 days)
Q <sub>3</sub>	3	3	3	Adverse effect level
U	3	3	3	Only 1 dosage and control in a pesticide formulation, small number of samples, and NOAEL not established. Author mentions that the capsule dosage is lower than what a wild bird would be estimated to ingest feeding on seeds.
Total AF	54	108	162	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.64	0.64	0.64	QCE = quantified critical endpoint
TRV	0.012	0.0059	0.0040	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.012	Test organism is in the same order and trophic level as the functional group members	none
2	0.0059	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.0040	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:** Mercury (Organic) CAS 7439-97-6

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in drinking water

**Test Endpoint:** NOAEL

**Reference:** Schroeder, H.A. and M. Mitchner, 1975, "Life-term effects of mercury, methylmercury and nine other trace metals on mice," *Journal of Nutrition*, 105:452.

**QCE:** 0.14 mg/kg-day                      Calculated, 1 ppm Hg as methylmercury acetate \*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Groups of 36 to 54 mice of each sex were exposed. One control group. 5 ppm Hg as methylmercury acetate for 70 days and 1 ppm subsequently in the drinking water. 5 ppm was toxic but 1 ppm appears to have beneficial effects, with the mice that survived gaining weight and living longer than litter mates given 1 ppm from time of weaning.
Q <sub>1</sub>	1	1	1	Body weight, tumors, edema, blanching of incisor teeth, life-spans and longevities.
Q <sub>2</sub>	1	1	1	Lifetime exposure
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Average study design with limited number of doses, and no reproductive endpoint or sensitive life stage examined. Random-bred white Swiss mice of Charles River CD strain. Both a NOAEL and LOAEL established.
M	0.5	0.5	0.5	Methylmercury acetate placed in drinking water.
Total AF	2	4	6	R * I * Q <sub>1</sub> * Q <sub>2</sub> * Q <sub>3</sub> * U = Total AF
QCE (mg/kg-day)	0.14	0.14	0.14	QCE = quantified critical endpoint
TRV	0.07	0.04	0.02	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.07	Test organism is in the same order and trophic level as the functional group members	none
2	0.04	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.02	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\*[(1 mg Hg<sub>2</sub>/L)\*(0.0051 L water/day\*\*)/0.0373 kg BW]=0.14 mg/kg BW-day

\*\*Ingestion rate of water calculated using allometric equation from the Wildlife Factors Handbook (EPA, 1993)  
WI=0.099BW<sup>0.9</sup>

**COPC:** Mercury (Organic) CAS 7439-97-6

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Verschuuren, H.G., et al., 1976, "Toxicity of methyl mercury chloride in rats. II. Reproduction study," *Toxicology*, 6:97-106.

**QCE:** 0.025 mg/kg-day Calculated

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	3 generation (> 1 yr. and during a critical life stage = chronic)
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	1	1	1	Chronic duration
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Good study design which provided adequate endpoints (behavior, growth, food intake, reproduction)
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.025	0.025	0.025	QCE = quantified critical endpoint
TRV	0.025	0.013	0.0083	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.025	Test organism is in the same order and trophic level as the functional group members	none
2	0.013	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.0083	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Mercury (Organic) CAS 7439-97-6

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (methylmercuric chloride in diet)

**Test Endpoint:** NOAEL

**Reference:** Khera and Tabacova, 1973, "Effects of methylmercuric chloride on the progeny of mice and rats treated before or during gestation," *Food and Cosmetic Toxicology*, 11:245-254.

**QCE:** 0.05 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	No prenatal effects were seen at 0.25 mg/kg-day however, an increased incidence of eye defects was seen. The study suggests that mercury was a contributory factor, in some unexplained way. This paper provides documentation of studies providing similar results.
Q <sub>1</sub>	1	1	1	Reproductive success measured, by #of pregnant mice, # of young per litter, weight of young, and postnatal survival. Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic duration
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Immature females of the Wistar strain were randomized into 5 groups each consisting of 35 rats. Doses included 0, 0.002, 0.01, 0.05, or 0.25 mg Hg/kg/day as CH <sub>3</sub> HgCl. The exposure was continued for sub-groups up to 192 days.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.05	0.05	0.05	QCE = quantified critical endpoint
TRV	0.03	0.01	0.008	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.03	Test organism is in the same order and trophic level as the functional group members	none
2	0.01	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.008	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Mercury (Organic) CAS 7439-97-6

**Test Organisms:** Swine (Omnivore, Order-Artiodactyla)

**Exposure Medium:** Oral in diet (organic form methylmercuric chloride CH<sub>3</sub>HgCl)

**Test Endpoint:** NOAEL

**Reference:** Chang C.W.J., R.M. Nakamura, and C.C. Brooks, 1977, "Effect of varied dietary levels and forms of mercury on swine," *J. Anim. Sci.*, 45:279-285.

**QCE:** 0.025 mg/kg-day specified 0.5 ppm [(0.5 mg/kg)x(2.5kg/day)/50 kg

**BW\***

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Thirty-two, three-way crossed pigs (Yorkshire, Duroc x Hampshire). Hg was mixed in feed at 0.5, 5.0, and 50.0 ppm. A control and group fed naturally contaminated feed was included. Feeding was controlled so that each pig received the same amount. Great variation existed between the level of Hg that accumulated in different tissue.
Q <sub>1</sub>	1	1	1	Endpoints were designed to measure the Hg accumulations in swine tissues (One gilt and one barrow from each group was removed for slaughter and examined at necropsy for fatty livers, lesions, enlarged lymph nodes, etc.), as well as determine teratogenic or behavioral effects on piglets born to exposure animals.
Q <sub>2</sub>	2	2	2	Subchronic exposure (exposure through breeding and birthing, however estimated at less than 50% of the total life span of a pig)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Good design, reproductive endpoint examined. LOAEL was established, however, difference between NOAEL and LOAEL levels is great.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.025	0.025	0.025	QCE = quantified critical endpoint
TRV	0.0063	0.0031	0.0021	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.0063	Test organism is in the same order and trophic level as the functional group members	None
2	0.0031	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.0021	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

\*Ingestion rate from allometric equation, BW from study.

**COPC:** Mercury (Organic) CAS 7439-97-6

**Test Organisms:** Cat (Carnivore, Order-Carnivora)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Charbornneau. S.M., et al., 1976, "Chronic toxicity of methylmercury in the adult cat," Interim Report, *Toxicology*, 5(1976):337-349.

**QCE:** 0.02 mg/kg-day Specified -either in naturally contaminated fish (methylmercury) or added to diet as methylmercuric chloride.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Each test group consisted of 8 random-bred domestic cats, 4 males and 4 females. Not rigorously examined, but no large variations within groups were evident
Q <sub>1</sub>	1	1	1	Food consumption, body weight, blood and urine changes and neurological status were examined. Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic duration (2 years)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Doses of 3, 8.4, 20, 46, 74 or 176 µg Hg/kg/day both in fish and as corn oil supplement. Older study, but thoroughly performed. Dose-response well-characterized for neurological effects, but reproductive effects not considered.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.02	0.02	0.02	QCE = quantified critical endpoint
TRV	0.005	0.003	0.002	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.005	Test organism is in the same order and trophic level as the functional group members	M322
2	0.003	Test organism is in a different order and same trophic level from the functional group members	M422A
3	0.002	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M132, M210, M210A, M222, M422

**COPC:** Mercury (Inorganic) CAS 7439-97-6

**Test Organisms:** Japanese quail (Omnivore, Order-Galliformes )  
**Exposure Medium:** Oral in diet  
**Test Endpoint:** NOAEL  
**Reference:** Hill and Shaffner, 1976, "Sexual maturation and productivity of Japanese quail fed graded concentrations of mercuric chloride," *Poultry Science*, 55:1449-1459 (cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals, Washington, DC).  
**QCE:** 0.47 mg/kg-day 4 ppm as mercury chloride in food,  
 4 mg/kg\*(0.015kg/day\*\*)/0.13 kg BW\*\*\*

Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of males and females tested. Experiment 1 used 10 groups of 10 hatchlings of P.W.R.C. Japanese quail, Experiment 2 used 10 groups of 10 hatchlings U.M.D. Japanese quail. Both experiments had comparable results.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint. Reproductive endpoints such as, hatchability, egg size, fertility and egg shell thinning assessed, neurotoxicity not studied.
Q <sub>2</sub>	1	1	1	Chronic exposure (28 weeks)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Well designed study. Multiple dose levels (0, 2, 4, 8,16,& 32 ppm) with both NOAELs and LOAELs established. 4 ppm Hg as HgCl <sub>2</sub> , but no neurological testing.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.47	0.47	0.47	QCE = quantified critical endpoint
TRV	0.47	0.24	0.16	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.47	Test organism is in the same order and trophic level as the functional group members	none
2	0.24	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.16	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\* Specified as 4 ppm in feed (turkey mash) in study

\*\* Ingestion rate estimated by Nagy (1987) allometric equation,  $0.0582(BW)^{0.651}$

\*\*\*BW estimated by Weimeyer article (0.13 kg)

**COPC:** Mercury (Inorganic) CAS 7439-97-6

**Test Organisms:** Swine (Omnivore, Order-Artiodactyla)

**Exposure Medium:** Oral in diet (as mercuric chloride-HgCl<sub>2</sub>)

**Test Endpoint:** NOAEL

**Reference:** Chang C.W.J., R.M. Nakamura, and C.C. Brooks, 1977, "Effect of varied dietary levels and forms of mercury on swine," *J. Anim. Sci.*, 45:279-285.

**QCE:** 0.25 mg/kg-day (HgCl<sub>2</sub>) specified 5 ppm (5 mg/kg)x(2.5kg/day)/50 kg BW\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Thirty-two, three-way crossed pigs (Yorkshire, Duroc x Hampshire). Hg was mixed in feed at 0.5, 5.0, and 50.0 ppm. A control and group fed naturally contaminated fed was included. Feeding was controlled so that each pig received the same amount. Great variation existed between the level of Hg that accumulated in different tissue.
Q <sub>1</sub>	1	1	1	Endpoints were designed to measure the Hg accumulations in swine tissues (One gilt and one barrow from each group was removed for slaughter and examined at necropsy for fatty livers, lesions, enlarged lymph nodes, etc.), as well as determine teratogenic or behavioral effects on piglets born to exposure animals.
Q <sub>2</sub>	2	2	2	Subchronic exposure (exposure through breeding and birthing, however estimated at less than 50% of the total life span of a pig)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Good design, reproductive endpoint examined, however no LOAEL established.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.25	0.25	0.25	QCE = quantified critical endpoint
TRV	0.063	0.031	0.021	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.063	Test organism is in the same order and trophic level as the functional group members	None
2	0.031	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.021	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

\*Ingestion rate from allometric equation , BW from study

**COPC:** Mercury (Inorganic) CAS 7439-97-6

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in drinking water

**Test Endpoint:** NOAEL

**Reference:** Schroeder and Mitchner, 1975, "Life-term effects of mercury, methylmercury and nine other trace metals on mice," *Journal of Nutrition*, 105:452.

**QCE:** 0.68 mg/kg-day Calculated 5 ppm Hg as mercuric chloride\*.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Groups of 36 to 54 mice of each sex were exposed. One control group. At 5 ppm longevity tended to decrease in males and increase in females.
Q <sub>1</sub>	1	1	1	Body weight, tumors, edema, blanching of incisor teeth, life-spans and longevities
Q <sub>2</sub>	1	1	1	Lifetime exposure
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint or sensitive life stage examined. Random-bred white Swiss mice of Charles River CD strain. 5 ppm Hg as mercuric chloride in the basal drinking water. Only one dose tested and no LOAEL established.
M	0.5	0.5	0.5	Placed in drinking water.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.68	0.68	0.68	QCE = quantified critical endpoint
TRV	0.34	0.17	0.11	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.34	Test organism is in the same order and trophic level as the functional group members	none
2	0.17	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.11	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\* [(5 mg Hg<sub>2</sub>/L water)\*(0.0051 L water/day\*\*)/0.0373 kg BW]

Ingestion rate of water calculated using allometric equation from the Wildlife Factors Handbook (EPA, 1993)  
WI=0.099BW<sup>0.9</sup>

## COPC:

Mercury (Inorganic) CAS 7439-97-6

<b>Test Organisms:</b>	Chickens (Omnivore, Order-Galliformes)
<b>Exposure Medium:</b>	Oral in drinking water
<b>Test Endpoint:</b>	NOAEL
<b>Reference:</b>	Thaxton, P., L.A. Cogburn, and C.R. Parkhurst, 1973, "Dietary mercury as related to the blood chemistry in young chickens," <i>Poultry Science</i> , 52:1212-1214 (cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals, Washington, DC).
<b>QCE:</b>	12.1 mg/kg-day (125mg/L)*(0.097 kg diet/kg bw/day)*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Results were inconsistent, however a similar study by Parkhurst and Thaxton, 1973 <sup>a</sup> reported toxic effects in young boilers at 250 ppm (similar study) including growth reduction, decreased feed and water efficiencies, alterations in the sizes of certain organs, immunosuppression, & mortality at 250 ppm as LOAEL.
Q <sub>1</sub>	1	1	1	Study determined minor effects of dietary Hg on plasma levels of glucose, total protein, total lipids and other blood chemistry. Endpoint is possible in receptor in the field.
Q <sub>2</sub>	1	1	1	Chronic exposure (6 weeks)
Q <sub>3</sub>	1	1	1	NOAEL (125 ppm see discussion above)
U	2	2	2	Adequate numbers of test animals, 120 young chickens at each 5 dose levels. Reasonable design. Multiple doses assessed (0, 5, 25, 125, 250 ppm) and NOAEL established but no LOAEL and results were inconsistent..
M	0.5	0.5	0.5	Administered as HgCl <sub>2</sub> in drinking water.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	12.1	12.1	12.1	QCE = quantified critical endpoint
TRV	6.05	3.03	2.02	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.05	Test organism is in the same order and trophic level as the functional group members	none
2	3.03	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	2.02	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

Parkhurst, C.R., and P. Thaxton, 1973. *Toxicity of mercury to young chickens. I. Effect on growth and mortality.* Poultry Science 52:273-276.

\* Wiseman, J., 1987, "Feeding of Non-ruminant Livestock," Butterworths; Boston, MA.

**COPC:** Methanol (Methyl alcohol) CAS 67-56-1

**Test Organisms:** Rat (Sprague-Dawley) (Omnivore, Order-Rodentia)

**Exposure Medium:** Gavage

**Test Endpoint:** NOAEL

**Reference:** US EPA, 1986, *Subchronic Toxicity Study with Methanol*, Office of Solid Waste, Washington, DC.

**QCE:** 500 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate number of rats examined
Q <sub>1</sub>	1	1	1	Provided adequate toxicological endpoints
Q <sub>2</sub>	1	1	1	Chronic—90 days
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Well-designed study provided adequate toxicological endpoints
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	500	500	500	QCE = quantified critical endpoint
TRV	500	250	170	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	500	Test organism is in the same order and trophic level as the functional group members	none
2	250	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	170	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Mercury (Organic) CAS 7439-97-6

**Test Organisms:** Pheasant (Omnivore, Order-Galliformes)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL

**Reference:** Fimreite, N., 1979, *Accumulation and Effects of Mercury on Birds*, Chapter 22 in *The biogeochemistry of Mercury in the Environment*, J.O. Nriagu, (ed.), Elsevier/North Holland Biomedical Press, New York.

**QCE:** 0.18 mg/kg-day Specified

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	From secondary source, no other information, cited in EPA, 1993, Wildlife Exposure Factors Handbook
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (egg production, shell thickness, hatchability)
Q <sub>2</sub>	1	1	1	Chronic duration (12 weeks)
Q <sub>3</sub>	2	2	2	LOAEL endpoint
U	2	2	2	Old study, secondary source, no NOAEL identified
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.18	0.18	0.18	QCE = quantified critical endpoint
TRV	0.015	0.008	0.005	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.015	Test organism is in the same order and trophic level as the functional group members	none
2	0.008	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.005	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:** Mercury (Organic) CAS 7439-97-6

**Test Organisms:** Mink (Carnivore, Order-Carnivora)

**Exposure Medium:** Oral in diet as methyl mercury chloride

**Test Endpoint:** NOAEL

**Reference:** Wobeser, G., N.O. Nielson, and B. Schiefer, 1976, "Mercury and mink II. Experimental methyl mercury intoxication," *Can. J. Comp. Med.*, 34-45.

**QCE:** 0.15 mg/kg-day (1.1 mg Hg/kg food \* 0.137 kg food /day)/(1 kg BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Five adult female mink per treatment group were sampled at 1.1, 1.8, 4.8, 8.3 and 15 ppm Hg in diet. Study for 93 days and not during a critical life stage.
Q <sub>1</sub>	1	1	1	Mortality, weight loss and ataxia. Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic study, 93 days
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Mercury doses of 1.8 ppm or greater produced significant adverse effects as a LOAEL. Mercury levels in tissue were evident at 1.1 ppm however, no significant effects observed. However, endpoint not based on reproduction.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.15	0.15	0.15	QCE = quantified critical endpoint
TRV	0.038	0.019	0.013	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.038	Test organism is in the same order and trophic level as the functional group members	none
2	0.019	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.013	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Methyl isobutyl ketone CAS 108-10-1

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** NOAEL

**Reference:** Microbiological Associates, 1986, (Obtained from Health Effects Assessment Summary Table (HEAST; EPA, 1993) as cited in Toxicological Benchmarks for Wildlife, ES/ER/TM-86/R1.

**QCE:** 250 mg/kg-day Assumed a body weight of 0.315 kg.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	No exposures during critical stages.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (liver and kidney function)
Q <sub>2</sub>	1	1	1	Chronic study (13-weeks)
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Exposure was subchronic
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	250	250	250	QCE = quantified critical endpoint
TRV	63	31	21	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	63	Test organism is in the same order and trophic level as the functional group members	none
2	31	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	21	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Methylene chloride (dichloromethane) CAS 75-09-2

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Drinking water

**Test Endpoint:** NOAEL

**Reference:** National Cancer Association, 1982, *24-Month Chronic Toxicity and Oncogenicity Study of Methylene Chloride in Rats*, prepared by Hazleton Laboratories, Inc. Vienna, VA, unpublished data cited in IRIS.

**QCE:** 5.85 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Both sexes tested. No juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (liver histology)
Q <sub>2</sub>	1	1	1	Long-term (2-year) study
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Well-conducted study, four doses tested: 5.85, 50, 125, and 250 mg/kg-day.
M	0.5	0.5	0.5	Placed in drinking water
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	5.85	5.85	5.85	QCE = quantified critical endpoint
TRV	5.85	2.93	1.95	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	5.85	Test organism is in the same order and trophic level as the functional group members	none
2	2.93	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	1.95	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Molybdenum CAS 7439-98-7

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** LOAEL

**Reference:** Miller, Price and Engel, 1956, "Added dietary inorganic sulfate and its effect upon rats fed molybdenum," *J. Nutrition*, 51:295-304.

**QCE:** 9.0 mg/kg-day (75 mg/kg-food)\*(5.37E-3 kg/day)/0.045 kg BW\*\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	21 day old Holtzman rats, 4/dosage group.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (body weight loss and bone deformities).
Q <sub>2</sub>	1	1	1	Chronic study (6-weeks)
Q <sub>3</sub>	2	2	2	LOAEL
U	3	3	3	Older study without any reproductive endpoints examined
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	9.0	9.0	9.0	QCE = quantified critical endpoint
TRV	0.75	0.38	0.25	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.75	Test organism is in the same order and trophic level as the functional group members	none
2	0.38	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.25	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\* Ingestion rate calculated from EPA Wildlife Exposure Factor Handbook, 1993.

\*\* BW specified in article

**COPC:** Molybdenum CAS 7439-98-7

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** LOAEL

**Reference:** Jeter, M.A., Davis, G.K., 1953, "The effect of dietary molybdenum upon growth, hemoglobin, reproduction, and lactation of rats," *J. Nutrition*, 54:215-220.

**QCE:** 2 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Long-Evans rats 4 or 8 pairs/group, 4 groups. 1 group received basal diet of 1,78 mg Cu/kg and <1 mg molybdenum/kg. Others received basal diet supplemented at 2, 8, or 14, mg Mo/kg
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic study (13-weeks)
Q <sub>3</sub>	2	2	2	LOAEL
U	3	3	3	Limited information
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2	2	2	QCE = quantified critical endpoint
TRV	0.2	0.08	0.06	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.2	Test organism is in the same order and trophic level as the functional group members	none
2	0.08	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.06	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Molybdenum CAS 7439-98-7

**Test Organisms:** Guinea pig (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** LOAEL

**Reference:** Arthur, D., 1965, "Interrelationships of molybdenum and copper in the diet of the guinea pig," *J. Nutrition*, 87:69-76.

**QCE:** 40 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Three part experiment. 1st part: 9 groups of 5 guinea pigs maintained on diet with 0.3-8000 mg Mo/kg. 2nd part: the levels of Cu and Mo were both varied with either 1, 10, or 20 mg Cu/kg and 0 or 2000 mg Mo/kg added to diet. 3rd part: 3 weanling guinea pigs supplied a low-copper basal diet with the addition of 2, 300, 500, 1000, or 2000 mg Mo.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	1	1	1	Chronic study (8-weeks)
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Good design, several tests conducted, but no reproductive endpoints examined.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	40	40	40	QCE = quantified critical endpoint
TRV	10	5.0	3.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	10	Test organism is in the same order and trophic level as the functional group members	none
2	5.0	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	3.3	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322,

**COPC:** Molybdenum CAS 7439-98-7

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in water

**Test Endpoint:** LOAEL

**Reference:** Schroeder, H.A. and M. Mitchener, 1971, "Toxic effects of trace elements on the reproduction of mice and rats," *Arch. Environ. Health*, 23:102-106.

**QCE:** 2.5 mg/kg-day (10mg/L)(7.5mL water/day)(1L/1000mL)/0.03kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate number of organisms tested over three generations
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	1	1	1	Chronic (3 generations)
Q <sub>3</sub>	2	2	2	LOAEL
U	1	1	1	Reduced reproductive success led to an incidence of runts.
M	0.5	0.5	0.5	Placed in the drinking water
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	2.5	2.5	2.5	QCE = quantified critical endpoint
TRV	2.5	1.3	0.83	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.5	Test organism is in the same order and trophic level as the functional group members	none
2	1.3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.83	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Naphthalene CAS 91-20-3

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** Shopp, G.M., et al., 1984, "Naphthalene toxicity in CD-1 mice: General toxicology and immunotoxicology," *Fundamental and Applied Toxicology*, 4:406-419.

**QCE:** 5.3 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of male and females tested (40-112 of each sex), no juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic (90-day) study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Reasonable design, but no reproductive endpoints or sensitive life stages examined.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5.3	5.3	5.3	QCE = quantified critical endpoint
TRV	1.3	0.66	0.44	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.3	Test organism is in the same order and trophic level as the functional group members	none
2	0.66	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.44	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Nickel CAS 7440-02-0

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Weber, C.W., and Reid, B.L., 1968, "Nickel toxicity in growing chicks," *Journal of Nutrition*, 95:612-616.

**QCE:** 37 mg/kg-day      500 ppm in diet converted to a dose using an estimated ingestion rate\* of 0.037 kg/day and a body weight of 500 g from the study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Subchronic toxicity studies with adequate numbers of animals
Q <sub>1</sub>	1	1	1	Production parameters (growth)
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	3	3	3	Older study, reproductive endpoints not evaluated
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	37	37	37	QCE = quantified critical endpoint
TRV	6.2	3.1	2.1	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.2	Test organism is in the same order and trophic level as the functional group members	none
2	3.1	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	2.1	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\*Estimated as  $0.0582 \text{ Wt}^{0.651}$  (kg) as cited in EPA, 1993. Wildlife Exposure Factors Handbook.

**COPC:** Nickel CAS 7440-02-0  
(nickel carbonate)

**Test Organisms:** Bovine (Herbivore, Order-Artiodactyla)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** O'Dell, G.D., et al., 1970a, "Effect of nickel supplementation on the production and composition of milk," *J. Dairy Science*, National Academy of Sciences, 1980, *Mineral Tolerance of Domestic Animals*, Washington, DC.

**QCE:** 4.1 mg/kg-day 1835mg/day/450 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q <sub>1</sub>	1	1	1	Growth and food intake
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	3	3	3	Limited information or supporting studies.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	4.1	4.1	4.1	QCE = quantified critical endpoint
TRV	0.23	0.11	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.23	Test organism is in the same order and trophic level as the functional group members	none
2	0.11	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.08	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Nickel CAS 7440-02-0

**Test Organisms:** Mallard Duck (Herbivore, Order-Anseriformes)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Cain, B.W. and E.A. Pafford, 1981, "Effects of dietary nickel on survival and growth of mallard duckling," *Archives of Environmental Contamination and Toxicology*, 10: 737-745.

**QCE:** 77.4 mg/kg-day (774mg/kg food)(78.2g food/day)(1kg/1000g)/0.782 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	36 ducklings divided into 6 cages with 6 birds per cage (3 male 3 female). 12 birds were given a dose of either 176, 774, or 1069 ppm.
Q <sub>1</sub>	1	1	1	Development endpoints measured (body weight, bill length, humerus, heart, liver, gizzard, kidneys).
Q <sub>2</sub>	1	1	1	Chronic study (60-90 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	The study considered exposure over 90 days, the 774 ppm dose was considered a NOAEL and the 1069 ppm was the LOAEL.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	77.4	77.4	77.4	QCE = quantified critical endpoint
TRV	38.7	19.4	12.9	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	38.7	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	19.4	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	12.9	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Nickel CAS 7440-02-0

**Test Organisms:** Beagle Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Ambrose, A.M. et al., 1976, "Long-term toxicologic assessment of nickel in rats and dogs," *J. Food Sci. Technology*, 13:181-187.

**QCE:** 114 mg/kg-day (2500mg/kg)(430g/day)(1kg/1000g)/9.41 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity study with adequate numbers of animals
Q <sub>1</sub>	1	1	1	Body weight gain
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Doses given to both males and females at: 0, 100, 1000, and 2500 ppm. No effects for dogs on diets at 100 and 1000 ppm.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	114	114	114	QCE = quantified critical endpoint
TRV	57.0	28.5	19.0	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	57.0	Test organism is in the same order and trophic level as the functional group members	M422A
2	28.5	Test organism is in a different order and same trophic level from the functional group members	M422
3	19.0	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:** Nickel CAS 7440-02-0

**Test Organisms:** Mallard (Herbivore, Order-Anseriformes)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Eastin, W.C., Jr. and O'Shea, T.J., 1981, "Effects of dietary nickel on mallards," *Journal of Toxicology Environmental Health*, 7(6):883-892.  
White, D.H., and M.P. Dieter, 1978, "Effects of dietary vanadium in mallard ducks," *Journal of Toxicology and Environmental Health*, 4:43-50.

**QCE:** 140 mg/kg-day (800mg/kg food)\*(0.205mg/day\*)/1.17 kg BW \*\*

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Subchronic toxicity study; variability not addressed
Q <sub>1</sub>	1	1	1	Egg production, hatchability, duckling survival; hematological parameters
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Reproductive endpoints evaluated, no LOAEL identified.
Total AF	8	16	24	R * I * Q <sub>1</sub> * Q <sub>2</sub> * Q <sub>3</sub> * U = Total AF
QCE (mg/kg-day)	140	140	140	QCE = quantified critical endpoint
TRV	17.5	8.75	5.83	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	17.5	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	8.75	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	5.83	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

\*Birds on 800ppm diet ate 15% more food than the 178g/day of the controls = 205g

\*\*Body weight is indicated in the 1978 White and Dieter study.

**COPC:** Nickel CAS 7440-02-0

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Ambrose, A.M., et al., 1976, "Long-term toxicologic assessment of nickel in rats and dogs," *J. Food Sci. Technology*, 13:181-187.  
 ABC (American Biogenics Corp.), 1986, *Ninety-Day Gavage Study in Albino Rats Using Nickel*, Draft Final Report submitted to Research Triangle Institute, P.O. Box 12194, Research Triangle Park, NC 27709.  
 RTI (Research Triangle Institute), 1987, *Two Generation Reproduction and Fertility Study of Nickel Chloride Administered to CD Rats in Drinking Water: Fertility and Reproductive Performance of the Po Generation (Part II of III) and F1 Generation (Part III of III)*, Final study report, Report submitted to Office of Solid Waste Management, U.S. EPA, Washington, DC.

**QCE:** 40 mg/kg-day (500mg/kg)(28g food/day)(1kg/1000g)/0.35 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity study with adequate numbers of animals.
Q <sub>1</sub>	1	1	1	Body weight gain
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Low survival in controls; however, another study by ABC, 1986 supports the 40 mg/kg/day NOAEL. A NOAEL for reproductive effects in a study by RTI (1987) was higher than the Ambrose study.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	40	40	40	QCE = quantified critical endpoint
TRV	20	10	6.7	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	20	Test organism is in the same order and trophic level as the functional group members	none
2	10	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	6.7	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Nitrate CAS 1594-56-5

**Test Organisms:** Rabbits (Herbivores, Order-Lagomorpha)

**Exposure Medium:** Oral in diet

**Test Endpoint:** Adverse effect level - reproductive (reduced fertility)

**Reference:** Southwest Vet., 1974, 24:246; HSDB.

**QCE:** 3994 mg/kg-day (from potassium nitrate)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Secondary source so information on number and sexes of animals tested unknown. Pregnant females tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	2	2	2	Subchronic exposure (days 23 through 27 of pregnancy)
Q <sub>3</sub>	3	3	3	Adverse effect level
U	2	2	2	Limited information, no reproductive endpoints and sensitive life stage examined. No NOAEL established.
Total AF	24	48	72	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3994	3994	3994	QCE = quantified critical endpoint
TRV	166.4	83.21	55.47	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	166.4	Test organism is in the same order and trophic level as the functional group members	none
2	83.21	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	55.47	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Nitrate CAS 1594-56-5

**Test Organisms:** Juvenile turkeys (Omnivore, Order-Galliformes)

**Exposure Medium:** Oral in drinking water

**Test Endpoint:** FEL

**Reference:** Humphreys Vet. Toxicol., 3rd Ed., 1988: HSDB.

**QCE:** 481 mg/kg-day (from sodium nitrate)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL
U	2	2	2	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
M	0.5	0.5	0.5	Placed in drinking water.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	481	481	481	QCE = quantified critical endpoint
TRV	26.7	13.4	8.9	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	26.7	Test organism is in the same order and trophic level as the functional group members	none
2	13.4	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	8.9	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:** Nitric acid CAS 7697-37-2

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Inhalation of mist

**Test Endpoint:** NOAEL

**Reference:** ACGIH, Documentation of TLVs, 5th ed., 1986, p. 428.

**QCE:** 41 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	No information.
Q <sub>1</sub>	0.5	0.5	0.5	Endpoint moderately likely to occur.
Q <sub>2</sub>	3	3	3	Acute duration (one exposure).
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	QCE derived from inhalation study with exposure to mist.
Total AF	13.5	27.0	40.5	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	41	41	41	QCE = quantified critical endpoint
TRV	3.0	1.5	1.0	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3.0	Test organism is in the same order and trophic level as the functional group members	none
2	1.5	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	1.0	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Phenol CAS 108-95-2

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in water

**Test Endpoint:** NOAEL

**Reference:** National Toxicology Program (NTP), 1983, *Teratologic Evaluation of Phenol in CD Rats and Mice*, Report prepared by Research Triangle Institute, Research Triangle Park, NC, NTIS PB83-247726, Gov. Rep. Announce Index, 83(25):6247.

**QCE:** 60 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Low variability because similar studies exhibited no effects at a dose rate on order of magnitude higher than the NOAEL
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reduced fetal body weight).
Q <sub>2</sub>	3	3	3	Acute (9 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	High quality studies with four dose levels and during a critical life stage (gestation).
M	0.5	0.5	0.5	Placed in drinking water
Total AF	1.5	3	4.5	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	60	60	60	QCE = quantified critical endpoint
TRV	40	20	13	Toxicity Reference Value = QCE/Total AF

**Appropriate Functional Groups:**

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	40	Test organism is in the same order and trophic level as the functional group members	none
2	20	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	13	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:**

**PCBs (Aroclor 1254) CAS 11097-69-1**

**Test Organisms:**

Pheasant (*Phasianus colchicus*, Omnivore, Order-Galliformes)

**Exposure Medium:**

Gelatin capsule with corn oil

**Test Endpoint:**

LOAEL

**Reference:**

Dahlgren, R.B., R.L. Linder, and C.W. Carlson, 1972, "Polychlorinated biphenyls: Their effects on penned pheasants," *Environmental Health Perspectives*, 1:89-101.

**QCE:**

1.8 mg/kg-day      12.5 mg/wk for 16 weeks; assumed BW of 1 kg (Wildlife Exposure Factors Handbook (EPA, 1993))

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Results presented in this paper are from 1970 and 1971 study. The 1970 part was reported in Dahlgren and Linder (1971). Two groups of 5 cocks each were given weekly gelatin capsule with control or 25 mg PCB. Hens (30 in 1970 and 34 in 1971) were given weekly a gelatin capsule with either 12.5 or 50 mg PCB. Some differences seen from 1 <sup>st</sup> to 2 <sup>nd</sup> year.
Q <sub>1</sub>	1	1	1	Number of eggs laid, egg fertility, hatchability, eggshell thickness, and chick behavior, weight and survival. Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic duration (16 weeks)
Q <sub>3</sub>	2	2	2	LOAEL endpoint
U	2	2	2	Very thorough study that looks at ecologically relevant endpoints (relatively insensitive neurological endpoints). Bolus dosing method might result in less absorption than daily exposure and exposure subchronic to adults only; however, effects noted were slight and variable, and dose-response varied from one year to the next, however, lowest dose (at which response was seen) was used.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.8	1.8	1.8	QCE = quantified critical endpoint
TRV	0.23	0.11	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.23	Test organism is in the same order and trophic level as the functional group members	none
2	0.11	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442

3	0.08	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342
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Dahlgren, R.B., and R.L. Linder, 1971, "Effects of polychlorinated biphenyls on pheasant reproduction, behavior, and survival," *Journal of Wildlife Management*, 35(2):315-319.

**COPC:** PCBs (Aroclor 1254) CAS 11097-69-1

**Test Organisms:** Oldfield mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** FEL

**Reference:** McCoy, G., et al., 1995, "Chronic polychlorinated biphenyls exposure on three generations of oldfield mice (*Peromyscus polionotus*): effects on reproduction, growth, and body residues," *Archives of Environmental Contamination and Toxicology*, 28:431-435.

**QCE:** 0.68 mg/kg-day Body weight: 0.014 kg (from Silva and Downing 1995), ingestion rate 0.135 g food/g BW/day.

Adjustment Factors (AF)				Justification for adjustment factor
	R	I	U	
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Well-designed long-term study showed relatively low variability in response
Q <sub>1</sub>	1	1	1	# of litters, offspring weights and survival. Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic duration (12 months, >1 yr. and during a critical life stage)
Q <sub>3</sub>	3	3	3	FEL
U	3	3	3	Only one dose level.
Total AF	9	18	27	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.68	0.68	0.68	QCE = quantified critical endpoint
TRV	0.076	0.038	0.025	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.076	Test organism is in the same order and trophic level as the functional group members	none
2	0.038	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.025	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

Linzey, A.V., 1987, "Effects of chronic polychlorinated biphenyls exposure on reproductive success of white-footed mice (*Peromyscus leucopus*)," *Archives of Environmental Contamination Toxicology*, 16: 455-460.

**COPC:** PCBs (Aroclor 1254) CAS 11097-69-1

**Test Organisms:** Mink (Carnivore, Order-Carnivora)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Aulerich, R.J. and R.K. Ringer, 1977, "Current status of PCB toxicity, including reproduction in mink," *Archives of Environmental Contamination and Toxicology*, 6:279.

**QCE:** 0.137 mg/kg-day      1 ppm in diet, 0.137 kg food/day (Bleavins and Aulerich 1981), and 1 kg BW (EPA, 1993)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	201 mink of both sexes studied
Q <sub>1</sub>	1	1	1	Reproductive performance (# of kits born). Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic duration (4.5 months)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Three dose levels (1, 5, and 15 ppm). Aroclor 1254 at 5 & 15 ppm in the diet reduced the number of offspring born alive.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.137	0.137	0.137	QCE = quantified critical endpoint
TRV	0.137	0.068	0.046	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.137	Test organism is in the same order and trophic level as the functional group members	M322
2	0.068	Test organism is in a different order and same trophic level from the functional group members	none
3	0.046	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

**COPC:** PCBs (Aroclor 1254) CAS 11097-69-1

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet in chow

**Test Endpoint:** NOAEL

**Reference:** Linder, R.E., T.B. Gaines, and R.D. Kimbrough, 1974, "The effect of polychlorinated biphenyls on rat reproduction," *Food and Cosmetic Toxicology*, 12:63-77.

**QCE:** 0.32 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Well-designed long-term study
Q <sub>1</sub>	1	1	1	Liver weights, # of litter, litter size, and survival of young. Ecologically relevant endpoints
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	1	1	1	Thorough, well-designed and analyzed, relevant study. Multiple doses examined at different generations.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.32	0.32	0.32	QCE = quantified critical endpoint
TRV	0.32	0.16	0.11	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.32	Test organism is in the same order and trophic level as the functional group members	none
2	0.16	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.11	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** PCBs (Aroclor 1254) CAS 11097-69-1

**Test Organisms:** Mink (Carnivore, Order-Carnivora)

**Exposure Medium:** Diet (Great Lakes fish)

**Test Endpoint:** NOAEL

**Reference:** Hornshaw, T.C., R.J. Aulerich, and H.E. Johnson, 1983, "Feeding Great Lakes fish to mink: Effects on mink and accumulation and elimination of PCBs by mink," *Journal of Toxicology and Environmental Health*, 11:933-946.

**QCE:** 0.03 mg/kg-day      0.21 ppm in diet, 0.15 kg/kg BW food factor for mink (EPA, 1993)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers tested. During the first year, 96 subadult mink were randomly assigned to 1 of six dietary groups (4 males and 12 females). First year: control, perch, sucker, carp, whitefish, and alewife. Second year 28 females assigned to either a standard mink or perch & sucker diet. Results of this study comparable to many others as mentioned in text.
Q <sub>1</sub>	1	1	1	Body weights of adults and offspring, reproductive performance (# of females whelped, kits whelped), liver weights. Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic duration (39 weeks)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Study provides a somewhat realistic means of exposure to mink, which are known to be considerably more sensitive to the toxicity of PCBs and related compounds than other mammalian carnivores, but study estimates based on different feeding diets.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.03	0.03	0.03	QCE = quantified critical endpoint
TRV	0.015	0.008	0.005	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.015	Test organism is in the same order and trophic level as the functional group members	M322
2	0.008	Test organism is in a different order and same trophic level from the functional group members	none
3	0.005	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

**COPC:** PCBs (Aroclor 1260) CAS 11096-82-5

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet in chow

**Test Endpoint:** NOAEL

**Reference:** Linder, R.E., T.B. Gaines, and R.D. Kimbrough, 1974, "The effect of polychlorinated biphenyls on rat reproduction," *Food and Cosmetic Toxicology*, 12:63-77.

**QCE:** 7.4 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Well-designed long-term study showed relatively low variability in response (10 males and 20 females)
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint: viability counts of offspring, body weights, livers, weights of spleen, heart, lungs, brain, kidneys, testes.
Q <sub>2</sub>	1	1	1	Chronic duration
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	1	1	1	Thorough, well-designed and analyzed, relevant study, testing different doses (0,5,20,100ppm). Started on diets at 3-4 weeks of age, doses continued through mating, gestation, and lactation. No LOAEL established.
M	1	1	1	Not applicable
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	7.4	7.4	7.4	QCE = quantified critical endpoint
TRV	7.4	3.7	2.5	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	7.4	Test organism is in the same order and trophic level as the functional group members	none
2	3.7	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.5	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Potassium chloride CAS 7447-40-7

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** LD<sub>50</sub>

**Reference:** Iyakuin Kenkyu, 21:57, RTECS.

**QCE:** 1,500 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL - lethality level
U	3	3	3	Limited information, no reproductive endpoints and sensitive life stage (offspring) examines. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1,500	1,500	1,500	QCE = quantified critical endpoint
TRV	18.5	9.3	6.2	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	18.5	Test organism is in the same order and trophic level as the functional group members	none
2	9.3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	6.2	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Potassium hydroxide CAS 1310-58-3

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** LD<sub>50</sub>

**Reference:** Smyth, H. F., et al., 1969, American Industrial Hyge. Assoc. , 30:470, as cited in *The Merck Index, An Encyclopedia of Chemicals, Drugs, and Biologicals*, Eleventh Edition, Merck & Co., Inc., Rahway, NJ.

**QCE:** 123 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Smyth article doesn't explain experiment, numbers not known
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL - lethality level
U	3	3	3	Limited information, no reproductive endpoints and sensitive life stage (offspring) examined. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	123	123	123	QCE = quantified critical endpoint
TRV	1.52	0.76	0.51	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.52	Test organism is in the same order and trophic level as the functional group members	none
2	0.76	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.51	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Potassium nitrate CAS 7757-79-1

**Test Organisms:** Guinea pigs (Omnivore, Order-Rodnetia)

**Exposure Medium:** Oral in drinking water

**Test Endpoint:** NOAEL

**Reference:** Act. Physio. Hung., 1989, 74:69.

**QCE:** 300 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Limited information, no sensitive life stage (offspring) examined.
M	0.5	0.5	0.5	Placed in drinking water.
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	300	300	300	QCE = quantified critical endpoint
TRV	50	25	17	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	50	Test organism is in the same order and trophic level as the functional group members	none
2	25	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	17	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Potassium nitrate CAS 7757-79-1

**Test Organisms:** Horses (Herbivore, Order-Artiodactyla)

**Exposure Medium:** Oral in diet

**Test Endpoint:** Adverse effect level

**Reference:** Booth Vet. Pharm. Therap., 5th Ed., 1982; HSDB

**QCE:** 1,000 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (caused illness but not death)
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	Adverse effect level
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1,000	1,000	1,000	QCE = quantified critical endpoint
TRV	12.3	6.17	4.12	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	12.3	Test organism is in the same order and trophic level as the functional group members	none
2	6.17	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	4.12	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Potassium nitrate CAS 7757-79-1

**Test Organisms:** Rabbits (Herbivores, Order-Lagomorpha)

**Exposure Medium:** Oral in diet

**Test Endpoint:** Adverse effect level

**Reference:** Southwest Vet., 1974, 24:246; HSDB.

**QCE:** 6,505 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Secondary source so information on number and sexes of animals tested unknown. Pregnant females tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	1	1	1	Chronic exposure (days 23 through 27 of pregnancy)
Q <sub>3</sub>	3	3	3	Adverse effect level
U	2	2	2	Limited information, no reproductive endpoints and sensitive life stage examined. No NOAEL established.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	6,505	6,505	6,505	QCE = quantified critical endpoint
TRV	542.1	271.0	180.7	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	542.1	Test organism is in the same order and trophic level as the functional group members	none
2	271.0	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	180.7	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Potassium nitrate CAS 7757-79-1

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** Adverse effect level

**Reference:** Acta Physiol. Hung., 1989, 74:69; HSDB.

**QCE:** 26mg/kg-day Average of the specified 19.8 during gestation and 32.4 during lactation.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of pregnant females and their offspring tested
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint, reproductive effects (adverse effects on newborns)
Q <sub>2</sub>	2	2	2	Subchronic study
Q <sub>3</sub>	3	3	3	AEL - deficient learning capacity and hyperactivity
U	2	2	2	Good design, reproductive endpoints and sensitive life stage (offspring) examined. No NOAEL established.
Total AF	12	24	36	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	26	26	26	QCE = quantified critical endpoint
TRV	2.2	1.1	0.72	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.2	Test organism is in the same order and trophic level as the functional group members	none
2	1.1	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.72	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Potassium nitrate CAS 7757-79-1

**Test Organisms:** Sheep (Herbivore, Order-Artiodactyla)

**Exposure Medium:** Oral in diet

**Test Endpoint:** FEL

**Reference:** Booth Vet Pharm Therap., 5th Ed., 1982; HSDB.

**QCE:** 1,000 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL - lethality level
U	3	3	3	Limited information, no reproductive endpoints and sensitive life stage (offspring) examined. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1,000	1,000	1,000	QCE = quantified critical endpoint
TRV	12.3	6.2	4.1	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	12.3	Test organism is in the same order and trophic level as the functional group members	none
2	6.2	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	4.1	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:****Potassium phosphate CAS 7778-53-2****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

**Exposure Medium:**

Oral in diet

**Test Endpoint:**LD<sub>50</sub>**Reference:**

Booth Vet. Pharm. Therap., 5th Ed., 1982; HSDB

**QCE:**1,400 mg/kg-day [potassium triphosphate (K<sub>3</sub>PO<sub>4</sub>)]

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL – lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established. Test chemical potassium triphosphate (K <sub>3</sub> PO <sub>4</sub> ).
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1,400	1,400	1,400	QCE = quantified critical endpoint
TRV	17.3	8.6	5.8	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	17.3	Test organism is in the same order and trophic level as the functional group members	none
2	8.6	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	5.8	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Potassium sulfate CAS 7778-80-5

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** LD<sub>90</sub>

**Reference:** Venugopal, B. and T.D. Luckey, 1978, *The Toxicity of Metals in Mammals*, New York, Plenum Press.

**QCE:** 2,340 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL – lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2340	2340	2340	QCE = quantified critical endpoint
TRV	28.9	15.0	10.0	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	28.9	Test organism is in the same order and trophic level as the functional group members	None
2	15.0	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	10.0	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Pyrene CAS 129-00-0

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** EPA, 1989, *Mouse Oral Subchronic Toxicity of Pyrene*, study conducted by Toxicity Research Laboratories, Muskegon, MI for the Office of Solid Waste, Washington, DC.

**QCE:** 75 mg/kg/day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Relatively small group sizes, variability not addressed
Q <sub>1</sub>	0.5	0.5	0.5	Although endpoint could occur, the ecological relevance is questionable since kidney lesions were mild.
Q <sub>2</sub>	1	1	1	Chronic study (13 weeks)
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	No reproductive endpoints examined
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	75	75	75	QCE = quantified critical endpoint
TRV	38	19	13	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	38	Test organism is in the same order and trophic level as the functional group members	none
2	19	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	13	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Selenium (Sodium selenite) CAS 7782-49-2

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)  
**Exposure Medium:** Diet  
**Test Endpoint:** NOAEL  
**Reference:** Ort, J.F. and J.D. Latshaw, 1978, "The toxic level of sodium selenite in the diet of laying chickens," *Journal of Nutrition*, 108:1114-1120.  
 EPA, 1993, *Ch. 9. Selenium Effects at Kesterson Reservoir, A Review of Ecological Assessment Case Studies from a Risk Assessment Perspective*, EPA/630/R-92/005.  
 Eisler, R., 1985, *Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish and Wildlife Service, Biological Report, 85(1.5).

**QCE:** 0.198 mg/kg-day (3mg/kg)\*(0.132kg/hen-day\*\*)/2kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers tested (100 female birds) and results are consistent with other studies in chickens and quail
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant: egg production, egg weight and fertility, hatchability
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	2	2	2	Older study but good design, however only females were tested
Total AF	2	4	6	R * I * Q <sub>1</sub> * Q <sub>2</sub> * Q <sub>3</sub> * U = Total AF
QCE (mg/kg-day)	0.198	0.198	0.198	QCE = quantified critical endpoint
TRV	0.099	0.050	0.033	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.099	Test organism is in the same order and trophic level as the functional group members	none
2	0.050	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.033	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\*\*Ingestion rate specified in table 2 page 1116 of article

**COPC:** Selenium (Sodium selenite) CAS 7782-49-2

**Test Organisms:** Mallard (Herbivore, Order-Anseriformes)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Heinz, G.H. et al., 1987, "Reproduction in mallards fed selenium," *Environmental Toxicology and Chemistry*, 6:423-433.  
 Eisler, R. 1985, *Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish and Wildlife Service, Biological Report, 85(1.5).  
 EPA, 1993, *Ch. 9. Selenium Effects at Kesterson Reservoir*, A Review of Ecological Assessment Case Studies from a Risk Assessment Perspective, EPA/630/R-92/005.

**QCE:** 0.5 mg/kg-day (5 mg/kg)(0.1 kg feed)/ 1 kg bird

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	10 pairs for five doses tested, study results consistent with other studies in chickens and quail, repro/devel. toxicity analysis only.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	1	1	1	Chronic study (2-4 mos.)
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	1	1	1	Reproductive study only with different forms of selenium
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	0.5	0.5	0.5	QCE = quantified critical endpoint
TRV	0.25	0.13	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.25	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	0.13	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	0.08	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Selenium CAS 7782-49-2

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Drinking water

**Test Endpoint:** NOAEL

**Reference:** Rosenfeld, I. and O.A. Beath, 1954, "Effect of selenium on reproduction in rats," *Proc. Soc. Exp. Biol. Med.*, 87:295-297.

**QCE:** 0.20 mg/kg-day (1.5mg/L water)(46mL water/day)(1L/1000mL)/0.35 kg BW

Adjustment Factors (AF)	Adjustment Factors (AF)			Justification for adjustment factor
	1	2	3	
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic toxicity studies with adequate numbers of animals
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction, number of young reared)
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	1	1	1	NOAEL endpoint
U	1	1	1	Older study, but analyzed 5 breeding cycles and 2 generations. A more recent study by Nobunaga et al. (1979) reports a NOAEL of 390 ug/kg/day selenite for mice reproductive success.
M	0.5	0.5	0.5	Placed in drinking water
Total AF	0.5	1.0	1.5	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	0.20	0.20	0.20	QCE = quantified critical endpoint
TRV	0.40	0.20	0.13	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.40	Test organism is in the same order and trophic level as the functional group members	none
2	0.20	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.13	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Selenium CAS 7782-49-2

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in water

**Test Endpoint:** FEL

**Reference:** Schroeder, H.A. and M. Mitchner, 1971, "Toxic effects of trace elements on the reproduction of mice and rats," *Archives of Environmental Health*, 23:102-106.

**QCE:** 0.76 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of females (104) tested, no males or juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction, number of young reared)
Q <sub>2</sub>	1	1	1	Chronic study (3 generations)
Q <sub>3</sub>	3	3	3	FEL endpoint (only one dose examined)
U	2	2	2	Good design, only reproductive endpoints (fetus) examined.
M	0.5	0.5	0.5	Placed in drinking water.
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	0.76	0.76	0.76	QCE = quantified critical endpoint
TRV	0.13	0.06	0.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.13	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.04	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

\*ingestion rate and BW specified in article

**COPC:****Selenium CAS 7782-49-2****Test Organisms:**

Sheep (Herbivore, Order-Artiodactyla)

**Exposure Medium:**

Diet

**Test Endpoint:**

FEL

**Reference:**Eisler, R., 1985, *Selenium Hazards to Fish, Wildlife, and Invertebrates: A Synoptic Review*, U.S. Fish and Wildlife Service, Biological Report, 85(1.5).**QCE:**

3.2 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (mortality)
Q <sub>2</sub>	3	3	3	Acute study
Q <sub>3</sub>	3	3	3	FEL - Lethal endpoint
U	3	3	3	Secondary source
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3.2	3.2	3.2	QCE = quantified critical endpoint
TRV	0.04	0.02	0.01	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.04	Test organism is in the same order and trophic level as the functional group members	none
2	0.02	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.01	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Selenium CAS 7782-49-2

**Test Organisms:** Black-crowned Night Heron (Carnivore, Order-Ciconiiformes)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL

**Reference:** Smith, G.J., et al., 1988, "Reproduction in black-crowned night herons fed selenium," *Lake and Reservoir Management*, 4(2):175-180.

**QCE:** 2.5 mg/kg-day      10 mg/kg in diet converted to dose by multiplying by 0.212 kg/day ingestion rate and dividing by 0.85 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of males and females tested (12 pairs), study results consistent with other studies in chickens and quails.
Q <sub>1</sub>	1	1	1	Hatching success, organ weights, blood measures, eggshell thickness, however 3-day-old hatchlings had shorter femurs and radius ulna legs and other hematological effects.
Q <sub>2</sub>	1	1	1	Chronic study
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	No NOAEL established. Reproductive endpoints examined.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.5	2.5	2.5	QCE = quantified critical endpoint
TRV	0.31	0.16	0.10	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.31	Test organism is in the same order and trophic level as the functional group members	none
2	0.16	Test organism is in a different order and same trophic level from the functional group members	AV310, AV322, AV322A, AV333, AV342
3	0.10	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222AAV232, AV233, AV241, AV242, AV432, AV432A, AV442

**COPC:** Silver CAS 7440-22-4

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Drinking Water

**Test Endpoint:** FEL

**Reference:** Rungby, J. and G. Danscher, 1984, "Hypoactivity in silver exposed mice," *Acta Pharmacology and Toxicology*, 55(5):398-401.

**QCE:** 3.0 mg/kg-day (0.09 mg/ 0.03 kg)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Females only for the long-term study
Q <sub>1</sub>	0.1	0.1	0.1	Not clearly relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	3	3	3	FEL
U	2	2	2	Only one dose, no NOAEL identified.
M	0.5	0.5	0.5	Placed in drinking water
Total AF	1.2	2.4	3.6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3.0	3.0	3.0	QCE = quantified critical endpoint
TRV	2.5	1.3	0.8	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	2.5	Test organism is in the same order and trophic level as the functional group members	none
2	1.3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.8	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Silver CAS 7440-22-4

**Test Organisms:** Swine (Omnivore, Order-Artiodactyla)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** Van Vleet, J.F., 1976, "Induction of lesions of selenium-vitamin E deficiency in pigs fed silver," *American Journal of Veterinary Research*, 37:1415-1420.

**QCE:** 68.0 mg/kg-day (converted with 0.034 kg/kg bw/d, Wiseman 1987)\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Two experiments with multiple test groups fed differing diets and supplemented with varying concentrations of silver acetate
Q <sub>1</sub>	1	1	1	Endpoints relevant (growth, mortality)
Q <sub>2</sub>	2	2	2	Subchronic study (4 weeks)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Good study design with adequate supporting sources (Walker, 1971)**
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	68.0	68.0	68.0	QCE = quantified critical endpoint
TRV	34.0	17.0	11.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	34.0	Test organism is in the same order and trophic level as the functional group members	None
2	17.0	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	11.3	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

\* Wiseman, J., 1987, "Feeding of Non-ruminant Livestock," Butterworths; Boston, MA.

\*\*Walker, F., 1971, "Experimental Argyria: A Model for Basement Membrane Studies," *British Journal of Experimental Pathology*, 52:589-593.

**COPC:** Silver CAS 7440-22-4

**Test Organisms:** Turkey (Omnivore, Order-Galliformes)

**Exposure Medium:** Oral

**Test Endpoint:** LOAEL

**Reference:** Friberg, L., et al., 1979, *Handbook on the Toxicology of Metals*, Elsevier/North Holland Biomedical Press, pp. 57-586.

**QCE:** 87.3 mg/kg-day (900 ppm converted with 0.097 kg/kg bw/d from Wiseman, 1987)\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate number of organisms used with effects exerted on the cardiovascular, hepatic, and hematopoietic systems
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (mortality)
Q <sub>2</sub>	1	1	1	Chronic duration (18 weeks)
Q <sub>3</sub>	2	2	2	LOAEL
U	1	1	1	Good study design
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	87.3	87.3	87.3	QCE = quantified critical endpoint
TRV	43.7	21.8	14.6	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	43.7	Test organism is in the same order and trophic level as the functional group members	none
2	21.8	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	14.6	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\* Wiseman, J., 1987, "Feeding of Non-ruminant Livestock," Butterworths; Boston, MA.

**COPC:** Silver CAS 7440-22-4

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** Walker, F., 1971, "Experimental argyria: A model for basement membrane studies," *British Journal of Experimental Pathology*, 52:589-593.

**QCE:** 65.0 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	3 groups of 12 Sprague-Dawley dosed at either 6, 12, 24 mM AgNO <sub>3</sub>
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoints (behavior, consumption, lethality, and appearance)
Q <sub>2</sub>	1	1	1	Chronic duration (12 weeks)
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Good study design
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	65.0	65.0	65.0	QCE = quantified critical endpoint
TRV	32.5	16.3	10.8	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	32.5	Test organism is in the same order and trophic level as the functional group members	none
2	16.3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	10.8	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Sodium chloride CAS 7647-14-5

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** FEL

**Reference:** Acta Pharmacol. Toxicol., 1983, 52:80; RTECS.

**QCE:** 701 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	3	3	3	Acute exposure (4 days)
Q <sub>3</sub>	3	3	3	FEL - lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	701	701	701	QCE = quantified critical endpoint
TRV	8.65	4.33	2.88	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	8.65	Test organism is in the same order and trophic level as the functional group members	none
2	4.33	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.88	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Sodium hydroxide CAS 1310-73-2

**Test Organisms:** Rabbits (Herbivore, Order-Lagomorpha)

**Exposure Medium:** Oral in diet

**Test Endpoint:** LD<sub>50</sub>

**Reference:** Arch. Exp. Pathol. Pharmacol., 1937, 184:587; RTECS.

**QCE:** 500 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL – lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	500	500	500	QCE = quantified critical endpoint
TRV	6.2	3.1	2.1	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.2	Test organism is in the same order and trophic level as the functional group members	None
2	3.1	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	2.1	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Sodium phosphate CAS 7601-54-9

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** LD<sub>50</sub>

**Reference:** Arzneimi-Forsch., 1957, 7:445m; RTECS.

**QCE:** 3,920 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL – lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3,920	3,920	3,920	QCE = quantified critical endpoint
TRV	48.4	24.2	16.1	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	48.4	Test organism is in the same order and trophic level as the functional group members	None
2	24.2	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	16.1	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Strontium CAS 7440-24-6

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** Storey, E., 1961, "Strontium rickets, bone calcium, and strontium changes," *Austral. Ann. Med.*, 10:213-222.  
 Marie, P.J. et al., 1985, "Effect of low doses of stable Sr on bone metabolism in rats," *Miner. Electrolyte Metab.*, 11:5-13.  
 Skoryna, S.C. and Fuskova, M., 1981, *Effects of stable strontium supplementation*, Handbook of Stable Strontium, S. C. Plenum Press, p. 593-613.

**QCE:** 190 mg/kg-day Specified in Storey article- there are higher NOAEL's stated in the other two articles

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Supportive studies. Both adult and young animals studied.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic duration (3 year)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Risk estimate based on strontium carbonate, not other salts. Supportive studies used stable strontium. Lack of developmental and reproductive data.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	190	190	190	QCE = quantified critical endpoint
TRV	95	48	32	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	95	Test organism is in the same order and trophic level as the functional group members	none
2	48	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	32	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Sulfate CAS 14808-79-8

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in diet

**Test Endpoint:** LD<sub>90</sub>

**Reference:** Venugopal, B. and T.D. Luckey, 1978, *The Toxicity of Metals in Mammals*, New York: Plenum Press.

**QCE:** 1,292 mg/kg-day (from potassium sulfate)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL – lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1292	1292	1292	QCE = quantified critical endpoint
TRV	15.95	7.98	5.32	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	15.95	Test organism is in the same order and trophic level as the functional group members	none
2	7.98	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	5.32	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Sulfate

**Test Organisms:** Turkeys (Omnivore, Order-Galliformes)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** Cakir, A., T.W. Sullivan, and F.B. Mather, 1978, "Alleviation of fluorine toxicity in starting turkeys and chicks with aluminum," *Poultry Science*, 57:498, as cited in National Academy of Sciences, 1980, Mineral Tolerance of Domestic Animals, Washington, DC.

**QCE:** 207.4 mg/kg-day (from aluminum sulfate)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	1-day old turkeys tested. Secondary source so information on number of animals tested not available.
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant
Q <sub>2</sub>	2	2	2	Subchronic study (28 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Limited information. Sensitive life stage examined. NOAEL established. Test organisms exposed to Al <sub>2</sub> (SO <sub>4</sub> )·18H <sub>2</sub> O
Total AF	8	16	24	R * I * Q <sub>1</sub> * Q <sub>2</sub> * Q <sub>3</sub> * U = Total AF
QCE (mg/kg-day)	207.4	207.4	207.4	QCE = quantified critical endpoint
TRV	25.93	12.96	8.64	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	25.93	Test organism is in the same order and trophic level as the functional group members	none
2	12.96	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	8.64	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:****Sulfuric acid** CAS 7664-93-9**Test Organisms:**

Guinea pig (Omnivore, Order-Rodnetia)

**Exposure Medium:**

Mist inhalation

**Test Endpoint:**

LOAEL

**Reference:**Cavender, F.L. et al., 1978, *Tox Environmental Health* 3:841-848.**QCE:**

2 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Number and sex of subjects unknown
Q <sub>1</sub>	0.5	0.5	0.5	Endpoint moderately likely to occur in the field.
Q <sub>2</sub>	1	1	1	Chronic study (140 days).
Q <sub>3</sub>	2	2	2	LOAEL
U	3	3	3	QCE derived from inhalation study with sulfuric acid.
Total AF	9	18	27	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2	2	2	QCE = quantified critical endpoint
TRV	0.22	0.11	0.07	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.22	Test organism is in the same order and trophic level as the functional group members	none
2	0.11	Test organism is in a different order and same trophic level from the functional group members	M121, M123, M422, M422A
3	0.07	Test organism is in a different order and trophic level from the functional group members	M122, M122A, M210, M210A, M222, M322

**COPC:** Terphenyl (meta-, ortho-) CAS 26140-60-3

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL

**Reference:** American Conference of Governmental Industrial Hygienists, TLVs., 4th ed. & suppl., 1980, p. 388.

**QCE:** 250 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Insufficient information on sex, age, breed.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic study (30 days)
Q <sub>3</sub>	2	2	2	LOAEL endpoint, elevated liver & kidney weight ratios, effects not observed for para-terphenyl.
U	3	3	3	Incomplete information. Multiple doses, but lower dose effects (if any) not discussed.
Total AF	36	72	108	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	250	250	250	QCE = quantified critical endpoint
TRV	6.9	3.5	2.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.9	Test organism is in the same order and trophic level as the functional group members	none
2	3.5	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	2.3	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Tetrachloroethylene CAS 127-18-4

**Test Organisms:** Mouse (Swiss-cox) (Omnivore, Order-Rodentia)

**Exposure Medium:** Gavage (in corn oil)

**Test Endpoint:** NOAEL (hepatotoxicity)

**Reference:** Buben, J.A., and E.J. O'Flaherty, 1985, "Delineation of the role of metabolism in the hepatotoxicity of trichloroethylene and perchloroethylene: A dose-effect study," *Toxicology and Applied Pharmacology*, 78:105-122.

**QCE:** 14 mg/kg-day Adjusted from 5 to 7 times per week.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Exposure not during critical time frame, males only
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (hepatotoxicity)
Q <sub>2</sub>	1	1	1	Chronic (6 weeks)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Mice were exposed for 5 days/week. 7 day/week exposure was estimated. Hepatotoxicity was observed at doses of 100mg/kg-day (probably increased triglycerides is adverse effect).
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	14	14	14	QCE = quantified critical endpoint
TRV	3.5	1.8	1.2	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3.5	Test organism is in the same order and trophic level as the functional group members	none
2	1.8	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	1.2	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** **Thallium CAS 7440-28-0**

**Test Organisms:** Quail (Omnivore, Order-Galliformes)

**Exposure Medium:** Oral in diet (bread)

**Test Endpoint:** FEL

**Reference:** Shaw, P.A., 1933, "Toxicity and deposition of thallium in certain game birds," *Journal of Pharmacology and Experimental Therapeutics*, 48(4):478-487.

**QCE:** 12 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Very old study, doses and effects poorly characterized, only high doses and lethal endpoints considered
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Acute duration
Q <sub>3</sub>	3	3	3	FEL for lethality
U	3	3	3	Very old study, poorly designed and analyzed
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	12	12	12	QCE = quantified critical endpoint
TRV	0.15	0.07	0.05	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.15	Test organism is in the same order and trophic level as the functional group members	none
2	0.07	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.05	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:** **Thallium CAS 7440-28-0**

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in Diet

**Test Endpoint:** LOAEL Hair loss

**Reference:** Downs, W., Scott, J., Steadman, L., Maynard, E., 1960, "Acute and sub-acute toxicity studies of thallium compounds," *Industrial Hygiene Journal*, pp. 399-406.

**QCE:** 1.8mg/kg-day Specified (Average between 1-3 depending on the BW)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number of male and female rats tested, no juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Good design, a variety of compounds tested, reproductive endpoints not examined. Compound is thallium acetate. Similar responsiveness for thallium oxide.
Total AF	16	32	48	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.8	1.8	1.8	QCE = quantified critical endpoint
TRV	0.11	0.06	0.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.11	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.04	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** **Thallium CAS 7440-28-0**

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Drinking Water

**Test Endpoint:** LOAEL Reduced sperm motility, etc.

**Reference:** Formigli, L., et al., 1986, "Thallium-induced testicular toxicity in the rat," *Environmental Research*, 40(2):531-539.

**QCE:** 0.75mg/kg-day Daily intake of 0.27 mg/rat, each rat weighing an avg. of 0.35 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Well characterized effects, consistent results among groups, only male reproduction toxicity was evaluated.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Only one dose, no NOAEL identified
M	0.5	0.5	0.5	Placed in drinking water
Total AF	3	6	9	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	0.75	0.75	0.75	QCE = quantified critical endpoint
TRV	0.26	0.12	0.08	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.26	Test organism is in the same order and trophic level as the functional group members	none
2	0.12	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.08	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Tin (Inorganic) CAS 7440-31-5

**Test Organisms:** Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Single oral dose, no vehicle specified

**Test Endpoint:** LD<sub>100</sub>

**Reference:** Kimbrough, R.D., 1976, "Toxicity and health effects of selected organotin compounds: A review," *Environmental Health Perspectives*, 14:51-56. as cited in Eisler, 1989.

**QCE:** 54 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Acute duration
Q <sub>3</sub>	3	3	3	Lethality endpoint
U	3	3	3	Limited information, secondary source
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	54	54	54	QCE = quantified critical endpoint
TRV	0.67	0.33	0.22	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.67	Test organism is in the same order and trophic level as the functional group members	M422A
2	0.33	Test organism is in a different order and same trophic level from the functional group members	M422
3	0.22	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:** Tin CAS 7440-31-5

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** deGroot, A.P., V. Felon, N. Til, 1973, "Short-term toxicity studies of some salts and oxides in rats," *Food and Cosmetic Toxicology*, 11:19-30, as cited in ATSDR, 1990.

**QCE:** 27.5mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Males and females tested, but only ten of each per dose group.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (body weight gain)
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Results consistent with study by Janssen et. al., 1985, no reproductive effects evaluated
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	27.5	27.5	27.5	QCE = quantified critical endpoint
TRV	3.44	1.72	1.15	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	3.44	Test organism is in the same order and trophic level as the functional group members	none
2	1.72	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	1.15	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Toluene CAS 108-88-3

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (corn oil)

**Test Endpoint:** NOAEL

**Reference:** National Toxicology Program (NTP), 1989, *Toxicology and Carcinogenesis Studies of Toluene in F/344 Rats and B6C3F1 Mice*, Technical Report Series No. 371, Research Triangle Park, NC.

**QCE:** 223 mg/kg-day                      312 mg/kg-day\*(5days fed/7 days in week)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Males and females tested. No juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic (13-week) exposure
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Good number of animals per treatment group tested (20 per dose). Supporting chronic toxicity studies for reproductive and development effects are lacking.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	223	223	223	QCE = quantified critical endpoint
TRV	55.8	27.9	18.6	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	55.8	Test organism is in the same order and trophic level as the functional group members	none
2	27.9	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	18.6	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Toluene CAS 108-88-3

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral gavage

**Test Endpoint:** LOAEL

**Reference:** Nawrot, P.S. and R.E. Staples, 1979, "Embryofetal toxicity and teratogenicity of benzene and toluene in the mouse," *Teratology*, 19:41A.

**QCE:** 260 mg/kg-day (0.3mL/kg BW)(0.866g/mL)(1000mg/1g)

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate number of organisms studied at three doses: 0.3, 0.5, and 1 mL/kg/day.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	1	1	1	Chronic
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Exposure to toluene was short but during critical lifestages. Fetal weights were significantly reduced.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	260	260	260	QCE = quantified critical endpoint
TRV	65	33	22	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	65	Test organism is in the same order and trophic level as the functional group members	none
2	33	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	22	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Tributyl phosphate CAS 126-73-8

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** LD<sub>50</sub>

**Reference:** Smyth, H.F. and C.P. Carpenter, 1944, *Journal of Industrial Hygiene and Toxicology*, 26:269.

**QCE:** 3,000 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Number of organisms used is unspecific, six is the minimum but the high end is not specified.
Q <sub>1</sub>	1	1	1	Endpoint likely to occur in field (lethality)
Q <sub>2</sub>	3	3	3	Acute duration
Q <sub>3</sub>	3	3	3	Lethality endpoint
U	3	3	3	Incomplete information.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3,000	3,000	3,000	QCE = quantified critical endpoint
TRV	37.0	18.5	12.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	37.0	Test organism is in the same order and trophic level as the functional group members	none
2	18.5	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	12.3	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Trichloroethylene CAS 79-01-6

**Test Organisms:** Cat (Carnivore, Order-Carnivora)  
**Exposure Medium:** Oral  
**Test Endpoint:** LD<sub>50</sub>  
**Reference:** Handbook of Toxicology, Vol. 5, 1959, p.76; RTECS.  
**QCE:** 5,864 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	2	2	2	Subchronic exposure
Q <sub>3</sub>	3	3	3	FEL - no effects on female fertility or neonatal survival
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
Total AF	54	108	162	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5,864	5,864	5,864	QCE = quantified critical endpoint
TRV	108.6	54.3	36.2	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	108.6	Test organism is in the same order and trophic level as the functional group members	M322
2	54.3	Test organism is in a different order and same trophic level from the functional group members	M422A
3	36.2	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M132, M210, M210A, M222, M442

**COPC:** Trichloroethylene CAS 79-01-6

**Test Organisms:** Dog (Omnivore, Order-Carnivora)

**Exposure Medium:** Oral

**Test Endpoint:** LD<sub>50</sub>

**Reference:** World Health Organization (WHO), 1985, "Trichloroethylene," *Environmental Health Criteria*, Vol. 50.

**QCE:** 5,680 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL - no effects on female fertility or neonatal survival
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	5680	5680	5680	QCE = quantified critical endpoint
TRV	70.1	35.1	23.4	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	70.1	Test organism is in the same order and trophic level as the functional group members	M422A
2	35.1	Test organism is in a different order and same trophic level from the functional group members	M422
3	23.4	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M322

**COPC:** Trichloroethylene CAS 79-01-6

**Test Organisms:** Rabbits (Herbivore, Order-Lagomorpha)

**Exposure Medium:** Oral

**Test Endpoint:** LD<sub>50</sub>

**Reference:** Handbook of Toxicology, Vol. 5, 1959, p.76; RTECS.

**QCE:** 7,330 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Duration of exposure unknown
Q <sub>3</sub>	3	3	3	FEL - no effects on female fertility or neonatal survival
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
Total AF	81	162	243	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	7,330	7,330	7,330	QCE = quantified critical endpoint
TRV	90.5	45.3	30.2	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	90.5	Test organism is in the same order and trophic level as the functional group members	none
2	45.3	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	30.2	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Trichloroethylene CAS 79-01-6

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** FEL

**Reference:** National Toxicology Program (NTP), 1982, *Carcinogenesis Bioassay of Trichloroethylene*, NTP 81-84, NIH Publication No. 86-2545.

**QCE:** 1000 mg/kd-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Males and females, but no juveniles tested.
Q <sub>1</sub>	0.1	0.1	0.1	Liver cancer used as endpoint
Q <sub>2</sub>	2	2	2	Chronic (103-week) exposure
Q <sub>3</sub>	3	3	3	FEL
U	2	2	2	Other studies corroborate these results. Principal study did evaluate lifetime exposure. Other, non-cancer endpoints not evaluated. Only one dose evaluated.
Total AF	2.4	4.8	7.2	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1000	1000	1000	QCE = quantified critical endpoint
TRV	417	208	139	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	417	Test organism is in the same order and trophic level as the functional group members	none
2	208	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	139	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Trichloroethylene CAS 79-01-6

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** Manson, J. M., et al., 1984, "Effect of oral exposure to trichloroethylene on female reproduction function," *Toxicology*, 32:229-242.

**QCE:** 100 mg/kg-day

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	2	2	2	Subchronic exposure
Q <sub>3</sub>	1	1	1	NOAEL - no effects on female fertility or neonatal survival
U	1	1	1	Limited information and reproductive endpoints and sensitive life stages examined.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	100	100	100	QCE = quantified critical endpoint
TRV	25	13	8.3	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	25	Test organism is in the same order and trophic level as the functional group members	none
2	13	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	8.3	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Trimethylolpropane-triester CAS 15625-89-5

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral in drinking water

**Test Endpoint:** LD<sub>50</sub>

**Reference:** Carpenter, C. P., et al., 1974, "Range finding toxicity data: list VIII," *Toxicology and Applied Pharmacology*, 28:313-319, issue no. 2.

**QCE:** 5.2 mL/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	Secondary source so information on number and sexes of animals tested unknown.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lethality)
Q <sub>2</sub>	3	3	3	Exposure duration unknown
Q <sub>3</sub>	3	3	3	FEL – lethality
U	3	3	3	Limited information and reproductive endpoints and sensitive life stages examined. No NOAEL established.
M	0.5	0.5	0.5	Placed in drinking water
Total AF	40.5	81	121.5	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mL/kg-day)	5.2	5.2	5.2	QCE = quantified critical endpoint
TRV	0.13	0.06	0.04	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.13	Test organism is in the same order and trophic level as the functional group members	none
2	0.06	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.04	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Uranium CAS 7440-61-1

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral intubation

**Test Endpoint:** NOAEL

**Reference:** Paternain, J.L., Domingo, J., Ortegs, A., Llobet, J., 1989, "The effects of uranium on reproduction, gestation, and postnatal survival in mice," *Ecotoxicology and Environmental Safety*, 17:291-296.

**QCE:** 3.07 mg/kg-day  $\frac{5 \text{ mg uranyl acetate} \times 238 \text{ mg uranium}}{\text{day} \quad 388.1 \text{ mg uranyl acetate}}$

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate numbers of males and females (1000 each)
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	2	2	2	Subchronic test, females were dosed only 2 weeks prior to mating and the pups were not grown out to adulthood with continued dosing.
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	Good design, reproductive endpoints and critical life stage examined.
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	3.07	3.07	3.07	QCE = quantified critical endpoint
TRV	1.54	0.768	0.512	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.54	Test organism is in the same order and trophic level as the functional group members	none
2	0.768	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.512	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Uranium CAS 7440-61-1

**Test Organisms:** Black Duck (Herbivore, Order-Anseriformes)

**Exposure Medium:** Oral

**Test Endpoint:** NOAEL

**Reference:** Haseltine, S., and L., Sileo, 1983, "Response of American black ducks to dietary uranium: A proposed substitute for lead shot," *Journal of Wildlife Management*, 47:1124-1129.

**QCE:** 160 mg/kg-day (1600mg/kg food)\*(0.125 kg day)/1.25 kg BW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate numbers of males and females (4 each per treatment) but no juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint
Q <sub>2</sub>	1	1	1	Chronic (6 weeks)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Reasonable design, but reproductive endpoints and critical life stage not examined.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	160	160	160	QCE = quantified critical endpoint
TRV	40	20	13	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	40	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	20	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	13	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

BW and food consumption from Opresko, "Toxicological Benchmarks for Wildlife:1994 Revision."

**COPC:** Uranium CAS 7440-61-1

**Test Organisms:** Rabbit (Herbivore, Order-Lagomorpha)

**Exposure Medium:** Oral

**Test Endpoint:** LOAEL

**Reference:** Maynard, E.A., and H.C. Hodge, 1949, "Studies of the Toxicity of Various Uranium Compounds When Fed to Experimental Animals," *Pharmacology and Toxicology of Uranium Compounds*.  
 Vuegtlin, I.C., and H.C. Hodge, *Nations Nuclear Energy Service, Division VI, Vol. I*, eds., McGraw Hill, NY, NY, p. 309-376.

**QCE:** 4.7 mg/kg-day\*\*

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	rabbits used, not specified if male or female
Q <sub>1</sub>	0.5	0.5	0.5	Endpoint is moderately unlikely to occur.
Q <sub>2</sub>	2	2	2	Subchronic (30 days) study.
Q <sub>3</sub>	2	2	2	LOAEL
U	3	3	3	Six test species per dosing group. Two endpoints measured.
Total AF	18	36	54	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	4.7	4.7	4.7	QCE = quantified critical endpoint
TRV	0.26	0.13	0.09	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.26	Test organism is in the same order and trophic level as the functional group members	none
2	0.13	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.09	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

\*\*0.01g/kg-day is the LOAEL for uranyl nitrate hexahydrate specified on page 375 of the article. 10mg/kg-day of uranyl nitrate hexahydrate converts to 4.7mg/kg BW-day of Uranium (MW of Uranium=288.03, MW of Uraynl i=502.12, therefore uranyl is 47% Uranium. (10mg/kg BW-day)\*(0.47)=4.7mg/kg-day

**COPC:****Vanadium (Sodium Metavandate) CAS 13718-26-8****Test Organisms:**

Rat (Omnivore, Order-Rodentia)

**Exposure Medium:**

Oral intubation

**Test Endpoint:**

LOAEL

**Reference:**Domingo, J.L., et al., 1986, "Effects of vanadium on reproduction, gestation, parturition and lactation in rats upon oral administration," *Life Science*, 39:819-824.**QCE:**2.1 mg/kg-day (0.4178)(5mg NaVO<sub>3</sub>/kg/day)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Adequate number of animals tested at three doses: 5, 10, and 20 mg NaVO <sub>3</sub> /kg/day.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (reproduction)
Q <sub>2</sub>	1	1	1	Chronic
Q <sub>3</sub>	2	2	2	LOAEL
U	2	2	2	Significant differences in reproductive parameters (e.g., number dead young/litter, size and weight of offspring, etc.) were observed at all dose levels.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.1	2.1	2.1	QCE = quantified critical endpoint
TRV	0.53	0.26	0.18	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.53	Test organism is in the same order and trophic level as the functional group members	none
2	0.26	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.18	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Vanadium (Vanadyl sulfate) CAS 27774-13-6

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Kubena, L.F. and T.D. Phillips, 1982, "Toxicity of vanadium in female leghorn chickens," *Poultry Science*, 62:47-50.

**QCE:** 1.7 mg/kg-day 25 ppm in diet converted to dose using an estimated 0.1 kg/day ingestion rate and 1.5 kg BW as indicated in study

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Subchronic study with adequate numbers of animals
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant (growth and egg production)
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Multiple doses evaluated, good statistical analysis of data, but only weight and egg production were evaluated.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	1.7	1.7	1.7	QCE = quantified critical endpoint
TRV	0.43	0.21	0.14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.43	Test organism is in the same order and trophic level as the functional group members	none
2	0.21	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	0.14	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

\*\*FI=0.0582(BW)0.651 cited in EPA Wildlife Exposures Handbook

**COPC:** Vanadium (Vanadyl sulfate) CAS 27774-13-6

**Test Organisms:** Mallard (Herbivore, Order-Anseriformes)

**Exposure Medium:** Oral in diet

**Test Endpoint:** NOAEL

**Reference:** White, D.H. and M.P. Dieter, 1978, "Effects of dietary vanadium in mallard ducks," *Journal of Toxicology and Environmental Health*.

**QCE:** 11.4 mg/kg-day 110 ppm in diet converted to dose using 0.121 kg/day ingestion rate and 1.17 kg BW as indicated in study.

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic study with adequate numbers of animals
Q <sub>1</sub>	0.5	0.5	0.5	Ecological relevance of endpoint questionable (altered lipid metabolism)
Q <sub>2</sub>	1	1	1	Chronic duration (12 weeks)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	No reproductive endpoint evaluated, three dose levels evaluated: 2.84, 10.36, and 110 ppm in food.
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	11.4	11.4	11.4	QCE = quantified critical endpoint
TRV	11.4	5.7	3.8	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	11.4	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	5.7	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	3.8	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

**COPC:** Vanadium (Vanadyl sulfate) CAS 27774-13-6

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Schroeder, H.A. and J.J. Balassa, 1967, "Arsenic, germanium, tin and vanadium in mice: Effects on growth, survival and tissue levels," *Journal of Nutrition*, 92:245-252.

ATSDR, Agency for Toxic Substance Disease Registry, 1990, *Draft: Toxicological Profile for Vanadium*, October.

**QCE:** 4.1 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	108 males and females tested
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (body weight gain)
Q <sub>2</sub>	1	1	1	Chronic duration
Q <sub>3</sub>	1	1	1	NOAEL
U	3	3	3	Older study, reproductive endpoints and sensitive life stage not examined,. Only one dose was tested, no LOAEL found.
Total AF	3	6	9	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	4.1	4.1	4.1	QCE = quantified critical endpoint
TRV	1.37	0.68	0.46	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.37	Test organism is in the same order and trophic level as the functional group members	none
2	0.68	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.46	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Vanadium (Ammonium metavanadate) CAS 7803-55-6

**Test Organisms:** Bovine (calves)

**Exposure Medium:** Gelatin capsule

**Test Endpoint:** NOAEL Clinical symptoms

**Reference:** Platonow, N. and H.K. Abbey, 1968, "Toxicity of vanadium in calves," *Veterinary Record*, 82:292.

**QCE:** 7.5 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	10 young males tested
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint.
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Older study, reproductive and sensitive endpoints not evaluated.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	7.5	7.5	7.5	QCE = quantified critical endpoint
TRV	0.94	0.47	0.31	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.94	Test organism is in the same order and trophic level as the functional group members	none
2	0.47	Test organism is in a different order and same trophic level from the functional group members	M121, M122, M122A, M123, M132
3	0.31	Test organism is in a different order and trophic level from the functional group members	M210, M210A, M222, M322, M422, M422A

**COPC:** Xylene CAS 1330-20-7

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** NOAEL

**Reference:** Marks, T., Ledoux, T., and Moore, J., 1982, "Teratogenicity of a commercial xylene mixture in the mouse," *J. Toxi. Environ. Health*, 9:97.

**QCE:** 2.06 mg/kg-day (Specified)

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Only females during gestation given the doses, no males or juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (mortality/histopathologic effects)
Q <sub>2</sub>	2	2	2	Subchronic exposure for pups (days 6-15 of gestation)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Well designed study, 3 replicates done, sensitive life stage and reproductive endpoint tested but pup neurotoxicity and neurodevelopment are probably more sensitive endpoints. Six dose levels: 0.52, 1.03, 2.06, 2.58, 3.10, and 4.13 mg/kg/day.
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	2.06	2.06	2.06	QCE = quantified critical endpoint
TRV	0.258	0.129	0.086	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	0.258	Test organism is in the same order and trophic level as the functional group members	none
2	0.129	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.086	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Xylene CAS 1330-20-7

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Oral (gavage)

**Test Endpoint:** NOAEL

**Reference:** National Toxicology Program (NTP), 1986, *NTP Technical Report on the Toxicology and Carcinogenesis of Xylene (Mixed) (60.2% m-Xylene, 13.6% p-Xylene, 17.0% Ethylbenzene, and 9.1% o-Xylene) (CAS No. 1330-20-7) in F344N/N Rates and B6C3F1 Mice (Gavage Studies)*, NIH Publication No. 86-2583, Research Triangle Park, N.C.

**QCE:** 250 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adult males and females tested. No juveniles tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (mortality/histopathologic effects)
Q <sub>2</sub>	1	1	1	Chronic (103-week) exposure
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Well-designed study with adequate numbers of animals from two species tested. Comprehensive histology was performed. A LOAEL was not determined.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	250	250	250	QCE = quantified critical endpoint
TRV	62.5	31.3	20.8	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	62.5	Test organism is in the same order and trophic level as the functional group members	none
2	31.3	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	20.8	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Zinc (zinc sulfate) CAS 68813-94-5

**Test Organisms:** Chicken (Omnivore, Order-Galliformes)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL

**Reference:** Stahl, J.L., Greger, J.L., and M.E. Cook, 1990, "Breeding hen and progeny when hens are fed excessive dietary zinc," *Poultry Science*, 69:259-263.  
Hoadley, J.E., S.H. Tao, and M.R. W. Fox, 1989, *Dietary cadmium and zinc effects on peripheral neuromuscular development*, 73rd Annual Meeting of the Federation of American Societies for Experimental Biology, New Orleans, LA., March 19-23, 1989, Federation of American Society for Experimental Biology, 4929.

**QCE:** 12 mg/kg-day                      20 mg/kg in diet converted to dose by 0.105 kg/day ingestion (from study) and 0.172 kg BW

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	1	1	1	Chronic study with adequate number of animals
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant (egg production)
Q <sub>2</sub>	1	1	1	Chronic duration
Q <sub>3</sub>	2	2	2	LOAEL
U	1	1	1	High quality study
Total AF	2	4	6	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	12	12	12	QCE = quantified critical endpoint
TRV	6.0	3.0	2.0	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	6.0	Test organism is in the same order and trophic level as the functional group members	none
2	3.0	Test organism is in a different order and same trophic level from the functional group members	AV422, AV432, AV433, AV442
3	2.0	Test organism is in a different order and trophic level from the functional group members	AV121, AV122, AV132, AV142, AV143, AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342

**COPC:** Zinc CAS 7440-66-6

**Test Organisms:** Ferret (Carnivore, Order-Carnivora)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Straube, E.F., Schuster, N.H., and Sinclair, A.J., 1980, "Zinc toxicity in the ferret," *Journal of Comparative Pathology*, 90:355-361.

**QCE:** 142 mg/kg-day                      500mg/kg\*0.170kg/day/0.60kgBW

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	3	3	3	NOAEL group was only 3 animals
Q <sub>1</sub>	1	1	1	Overall health, weight gain, hematological measurements, levels of zinc in organs
Q <sub>2</sub>	1	1	1	Chronic duration (48, 138 and 191 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Adequate study design, but no reproductive endpoints examined.
Total AF	6	12	18	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	142	142	142	QCE = quantified critical endpoint
TRV	23.7	11.8	7.89	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	23.7	Test organism is in the same order and trophic level as the functional group members	M322
2	11.8	Test organism is in a different order and same trophic level from the functional group members	none
3	7.89	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M123, M210, M210A, M222, M422, M422A

**COPC:** Zinc CAS 68813-94-5

**Test Organisms:** Mallard (Herbivore, Order-Anseriformes)

**Exposure Medium:** Diet

**Test Endpoint:** LOAEL

**Reference:** Gasaway, W. C. and I. O. Buss, 1972, "Zinc toxicity in the mallard duck," *J. Wildlife Management*, 36:1107-1117.

**QCE:** 207 mg/kg-day (3000mg/kg food)\*(0.0363kg/day)/(0.525 kg BW)

Adjustment Factors (AF)	Justification for adjustment factor			
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	15 males and 15 females tested, no juveniles
Q <sub>1</sub>	1	1	1	Endpoint ecologically relevant (mortality, BW, and blood chemistry)
Q <sub>2</sub>	2	2	2	Subchronic duration
Q <sub>3</sub>	2	2	2	LOAEL
U	1	1	1	High quality study, but no NOAEL dose was found, all doses were toxic
Total AF	8	16	24	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	207	207	207	QCE = quantified critical endpoint
TRV	25.9	12.9	8.63	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	25.9	Test organism is in the same order and trophic level as the functional group members	AV142, AV143
2	12.9	Test organism is in a different order and same trophic level from the functional group members	AV121, AV122, AV132
3	8.63	Test organism is in a different order and trophic level from the functional group members	AV210, AV210A, AV221, AV222, AV222A, AV232, AV233, AV241, AV242, AV310, AV322, AV333, AV342, AV422, AV432, AV433, AV442

\*Ingestion rate specified in article, converted to ounces/10 days to kg/day

\*\*BW estimated by interpolation of values given in the Wildlife Exposures Handbook and an average of 77% weight loss(given in article).  $682 * 0.77 = 525$  g

**COPC:** Zinc (zinc oxide) CAS 7440-66-6

**Test Organisms:** Rat (Omnivore, Order-Rodentia)

**Exposure Medium:** Diet

**Test Endpoint:** NOAEL

**Reference:** Schlicker, S.A. and D.H. Cox, 1968, "Maternal dietary zinc and development and zinc, iron and copper content of the rat fetus," *Journal of Nutrition*, 95:287-294.  
ATSDR, Agency for Toxic Substance Disease Registry, 1988, *Draft: Toxicological Profile for Zinc*, December.

**QCE:** 170 mg/kg-day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Smaller number (60) of females tested.
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (developmental effects)
Q <sub>2</sub>	1	1	1	Chronic duration (36 days)
Q <sub>3</sub>	1	1	1	NOAEL
U	2	2	2	Good design, reproductive endpoints and sensitive life stage examined, only 2 doses tested (2000 and 4000 ppm). 4000 ppm considered a LOAEL.
Total AF	4	8	12	$R * I * Q_1 * Q_2 * Q_3 * U = \text{Total AF}$
QCE (mg/kg-day)	170	170	170	QCE = quantified critical endpoint
TRV	43	21	14	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	43	Test organism is in the same order and trophic level as the functional group members	none
2	21	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	14	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322

**COPC:** Zirconium CAS 7440-67-7

**Test Organisms:** Mouse (Omnivore, Order-Rodentia)

**Exposure Medium:** Drinking water

**Test Endpoint:** NOAEL

**Reference:** Schroeder, H.A. et al., 1968, "Zirconium, niobium, antimony and fluorine in mice: effects of growth survival and tissue levels," *Journal of Nutrition*, 95:95-101.

**QCE:** 1.74 mg/kg-day (5mg/L water)(7.5mL water/day)(1L/1000mL)/0.03 kg BW + 0.488 mg/kg/day

Adjustment Factors (AF)				Justification for adjustment factor
R	1	2	3	R = 1 is AF for same order and trophic level R = 2 is AF for different order and same trophic level R = 3 is AF for different order and trophic level
I	2	2	2	Adequate number of animals tested but at only one dose (5 ppm in water and 2.66 ppm in food).
Q <sub>1</sub>	1	1	1	Ecologically relevant endpoint (lifespan, longevity)
Q <sub>2</sub>	1	1	1	Chronic
Q <sub>3</sub>	1	1	1	NOAEL
U	1	1	1	No significant treatment effects were observed at the 5 ppm dose. Since the study considered exposure throughout the lifespan this was considered the NOAEL.
M	0.5	0.5	0.5	Placed in drinking water
Total AF	1	2	3	$R * I * Q_1 * Q_2 * Q_3 * U * M = \text{Total AF}$
QCE (mg/kg-day)	1.74	1.74	1.74	QCE = quantified critical endpoint
TRV	1.74	0.87	0.58	Toxicity Reference Value = QCE/Total AF

R Value	TRV (mg/kg-day)	Justification	Appropriate Functional Group
1	1.74	Test organism is in the same order and trophic level as the functional group members	none
2	0.87	Test organism is in a different order and same trophic level from the functional group members	M422, M422A
3	0.58	Test organism is in a different order and trophic level from the functional group members	M121, M122, M122A, M132, M210, M210A, M222, M322