5: Proposed Groupings of Toxic Air Contaminants

1. Background

Many toxic air contaminants (TACs) regulated under Cleaner Air Oregon (CAO) share structural or toxicological similarities.[1] In some of these cases, the similarities are sufficient to apply the same toxicity reference value (TRV) to all members of the group of TACs (refer to section 2). In other cases, the members of a group, sometimes called a "class," of TACs cause the same specific health effects in the same way (i.e., they have the same mode of action), but members of the class vary in the amount needed to cause those effects (Refer to section 3). In still other cases, especially in the case of metals and compounds containing those metals, the toxicity is based on the metal component of those compounds (refer to section 4). In such cases, the modeled or monitored concentrations of those compounds need to be adjusted by molecular weight prior to comparison to the TRV so that only the metal component of that substance is compared to the TRV.

The purpose of this document is to describe the different groups and classes of TACs for which DEQ is proposing TRVs during the 2025 TAC Review and Update Rulemaking and how DEQ intends for the members of those groups and classes to be compared against their TRVs.

2. Chemical Groups that Can be Summed and Compared Directly to a TRV that Applies to the Group

Chemicals within the groups in this section are so similar that toxicologists consider the members of the group equivalent in toxicity. For example, there is one TRV that applies to all three trimethylbenzenes (Table 1). All members of the group can affect health at the same level of exposure so their measured or monitored concentrations can be directly compared to a single TRV for the group either individually or in sum.

Table 1. Chemical Class Names, Members of Class and DEQ Proposal.

Chemical group name in TRV workbook (CAS RN or ID#)	Members of group (CAS RN)	Difference in approach from existing rule
Trimethylbenzenes (25551-13-7)	1,2,3-Trimethylbenzene (526-73-8) 1,2,4-Trimethylbenzene (95-63-6) 1,3,5-Trimethylbenzene (108-67-8)	Existing rule has TRVs from various sources for individual trimethylbenzenes. In 2023, OEHHA published new TRVs and stated that they apply to these three isomers.

[1]In the scientific and regulatory communities, there is a lot of interest in regulating perfluoroalkyl substances (PFAS) as a class. However, none of DEQ's authoritative sources have inhalation TRV options for PFAS either individually or as a group. For now, DEQ is only able to apply individual TRVs for individual PFAS chemicals (see DEQ's document titled *Proposed TRVs where DEQ is the Authoritative Source* for more information on PFAS TRVs).

1,3-Dichloropropene (542-75-6) Mixtures of *cis*- and *trans*-1,3-dichloropropene	*cis*-1,3-Dichloropropene (10061-01-5) *trans*-1,3-Dichloropropene (10061-02-6)	Existing rule does not distinguish between isomers, and there is no proposed change in TRVs. However, the toxicological studies underlying the existing TRVs were done using "technical grade 1,3-dichloropropene" which is made up of approximately equal parts cis- and trans- isomers.
Cresols (1319-77-3)	m-Cresol (108-39-4) p-Cresol (106-44-5) o-Cresol (95-48-7)	No change in grouping from existing rule.
Polybrominated diphenyl ethers – except -BDE (447)	DEQ proposes to apply the TRV for octabrominated diphenyl ethers (32536-52-0) to all PBDEs except decabrominated diphenyl ether. This is consistent with ATSDR's approach.	No change in grouping from existing rule.
PCB congeners (1336-36-3) Unspeciated mixtures of PCB congeners	This proposed grouping follows OEHHA's approach and allows for use of their TRV, which applies to this class.	No change in grouping from existing rule. However, DEQ does propose to differentiate between evaporated PCBs mixtures and particulate PCB mixtures, which was already suggested by both EPA and OEHHA.
Toluene diisocyanates (26471-62-5)	Toluene-2,6-diisocyanate (91-08-7) Toluene-2,4-diisocyanate (584-84-9)	TRVs in existing rule are from 2016 OEHHA and are listed separately but identically for the two isomers. Proposed TRVs are 2018 ATSDR values. ATSDR does not distinguish between isomers and applies their values to any mixture of the two. DEQ proposes to follow this approach.
Xylenes (1330-20-7)	p-Xylene (106-42-3) o-Xylene (95-47-6) m-Xylene (108-38-3)	No change in grouping from existing rule.

3. Chemical Classes with Toxicity Equivalency Factors or Relative Potency Factors

Groups of TACs described in this section are typically called "classes" of TACs. Individual members of these classes of TACs are called "congeners." Congeners within these classes share similar chemical structures and similar modes of action as in section 2 above, but the congeners differ in the amount needed to activate that common mode of action. In other words, they have different potencies relative to one another. For these classes of TACs, risk assessors identify a representative congener, typically the most toxic/potent in the class, and designate it as the "index congener." Risk assessors then apply toxicity equivalency factors (TEFs) or relative potency factors (RPFs) to the rest of the congeners in those classes. The TEF or RPF describes how toxic or potent each congener is relative to the index congener in the class.

For these classes of TACs, DEQ calculated TRVs for individual congeners by applying the TEF or RPF of the individual congener to the TRV for the index congener. Risk assessors can then assess risk from the whole class by first calculating risk from each congener in the class and then summing the risk from all congeners in the class. The next two subsections identify the common mode of action and index congener for the two classes of TACs that are in this category.

3.1 Chlorinated and Brominated Dioxins and Furans & Dioxin-Like Polychlorinated and Polybrominated Biphenyls.

The index congener for the following chemical classes is 2,3,7,8-tetrachlorodibenzo-p-dioxin (2,3,7,8-TCDD) (1746-01-6):

- chlorinated dioxins
- chlorinated furans
- brominated dioxins
- brominated furans
- dioxin-like polychlorinated biphenyls
- dioxin-like polybrominated biphenyls

The common mode of action for this class is mediated by an intracellular receptor called the aryl hydrocarbon receptor. The TEF for each congener is determined by how efficiently that congener binds and activates that receptor relative to the index congener (2,3,7,8-TCDD), which is the most potent activator of the aryl hydrocarbon receptor. The U.S. Environmental Protection Agency (EPA) and World Health Organization (WHO) have both recommended a specific set of TEFs for dioxins, furans, and dioxin-like PCBs (EPA 2010; DeVito et al. 2024). DEQ proposes to continue using the EPA's recommended TEFs because other jurisdictions in the United States have not yet adopted the WHO values. This proposal means no change from what is currently in rule.

In this rulemaking, DEQ proposes to apply TEFs for chlorinated dioxins, furans, and dioxin-like polychlorinated biphenyls (PCBs) to their brominated analogues and to include risk from brominated dioxins, furans, and dioxin-like polybrominated biphenyls (PBBs) in the risk for the dioxin/furan class. This approach is recommended in a peer-reviewed publication (Van den Berg et al. 2013), and ATSAC has previously communicated approval of this proposed approach in a series of email communications (DEQ 2023).

3.2 Carcinogenic Polycyclic Aromatic Hydrocarbons (cPAHs).

The index congener for carcinogenic PAHs, or cPAHs, is benzo[a]pyrene. All cPAHs can cause mutations, or permanent changes in DNA, which contributes to increased risk of various cancers. DEQ proposes to continue using a collection of RPFs used by the Minnesota Department of Health (MDH 2016) for derivation of congener-specific cancer TRVs. These are the same RPFs that DEQ applied to calculate the TRVs currently in

rule, so this is not a proposed change. Many of the RPFs Minnesota uses come from the EPA with others filled in from California's Office of Environmental Health Hazard Assessment (OEHHA) for congeners for which EPA did not have values. DEQ only applies the RPF system to cPAHs for cancer risk. DEQ proposes to continue evaluating noncancer hazard for cPAHs based on congener-specific information. Currently, congener-specific noncancer TRVs are only available for benzo[a]pyrene and no other cPAH congeners.

Additionally, DEQ proposes to continue evaluating both cancer risk and noncancer hazard separately for naphthalene and 1- and 2-methylnaphthalenes. They each have their own separate toxicity information outside of the RPF system.

4. Inorganic TACs and their Associated Compounds

Metals and other inorganic ions like fluorides and cyanides come in different physical forms (fumes, particulates, aerosols, etc.) and are often combined, or "compounded," with a variety of other substances. In this section, DEQ provides clarity about how these types of TACs are grouped and how DEQ proposes to apply various TRVs to these groups.

4.1 Metals

In general, DEQ has always adjusted concentrations of metals by molecular weight such that only the amount of the component of the emitted substance that is the metal is compared against their TRVs. This is the method used by all the authoritative sources DEQ looks to for evaluating toxicity from metals via inhalation. Unless otherwise noted, DEQ proposes to continue adjusting concentrations of metal-containing compounds by molecular weight to evaluate toxicity based on that proportion of the compound that is the metal.

The TRV workbooks shared with ATSAC list only the metal "…and compounds" with the TRVs intended to be applied to all compounds in that group. DEQ will share the lists of specific compounds that fall under these headings with regulated facilities.

View workbooks at the following links: ATSAC Workbook 1: DEQ Proposed TRVs and ATSAC Workbook 2: TRV Derivation.

Metals with TRVs are listed below. In some cases, DEQ has further subdivided groups of metal-containing compounds by factors such as solubility or form. In other cases, there are compound-specific considerations. The list below makes note of such exceptions and whether those exceptions are newly proposed with this rulemaking or are already being applied under current implementation.

- **Aluminum and compounds (7429-90-5)**
- **Antimony and compounds (7440-36-0)**
- **Arsenic and compounds (7440-38-2):** Arsine gas has its own TRVs and should not be grouped with other arsenic-containing compounds. This is not a change from current program implementation.
- **Beryllium and compounds (7440-41-7)**
- **Cadmium and compounds (7440-43-9)**
- **Chromium VI and compounds (7738-94-5 and 18540-29-9):** DEQ divides chromium VI compounds into acid mist aerosols (typically from chrome plating operations) and chromate or dichromate particulate. While the cancer and chronic noncancer TRVs are the same for these groups, the acute TRVs differ due to the more intense corrosivity component of the acid mist in short-term exposure scenarios

relative to the particulate. ATSDR also uses this approach, and it is not a change from current program implementation.

- **Chromium III and compounds (16065-83-1):** DEQ is proposing to divide trivalent chromium into soluble and insoluble compounds with different sets of TRVs consistent with OEHHA's approach. This is a new TRV and metal group for DEQ proposed in this rulemaking.
- **Cobalt and compounds (7440-48-4):** DEQ proposes to divide cobalt compounds into soluble and insoluble compounds consistent with OEHHA's approach. This proposal is a change from existing rule.
- **Copper and compounds (7440-50-8)**
- **Lead and compounds (7439-92-1):** DEQ splits lead chromate by molecular weight into lead and chromate fraction and compares each fraction against its corresponding set of TRVs.
- **Manganese and compounds (7439-96-5)**
- **Mercury and compounds (7439-97-6)**
- **Nickel and compounds (364):** DEQ previously split nickel compounds into soluble and insoluble compounds. However, OEHHA and ATSDR's most recent toxicological information consolidates these compounds into one, and DEQ proposes to follow their approach in this rulemaking. Nickel oxide has its own entry and TRVs, separate from "nickel and compounds." The chronic noncancer TRV for nickel oxide is based on a different critical study and slightly different critical effects than for other nickel compounds. Nickel oxide also has a different interspecies dosimetric adjustment factor (DAF) compared to other nickel compounds. The justification and details for these differences are detailed starting at the bottom of page 110 of OEHHA's 2012 Nickel Reference Exposure Levels document (OEHHA 2012). The noncancer acute and cancer TRVs from the rest of "nickel and compounds" should be applied to nickel oxide.
- **Selenium and compounds (7782-49-2)**
- **Uranium and compounds (7440-61-1):** DEQ is proposing to divide these into soluble and insoluble groups as ATSDR has different TRVs available for the different groups.
- **Vanadium and compounds (7440-62-2):** DEQ is proposing to consolidate "vanadium fume or dust" and "vanadium pentoxide" into a single "vanadium and compounds" TRV. This is consistent with ATSDR and EPA.

4.2 Non-Metal Inorganic or Ionic TACs

There are other types of TACs besides metals that are also inorganic or ionic that tend to form compounds with various other substances. Like metals, DEQ and other authoritative sources have always adjusted concentrations of these compounds by molecular weight such that only the active portion of the substance (the part named in the header for the group of compounds) is compared against the TRVs. DEQ proposes to continue doing that for these non-metal, inorganic and ionic TACs.

Like metals, DEQ will provide regulated facilities with specific lists of the compounds that fall within each group.

TACs in this category are listed below with exceptions to the general approach above or compound-specific exceptions noted.

- **Cyanide and inorganic compounds**
- **Fluoride and inorganic compounds:** DEQ previously listed hydrogen fluoride, fluoride, and fluorine gas separately. DEQ proposes to consolidate hydrogen fluoride and fluoride under one heading "Fluoride and compounds" with the TRV for hydrogen fluoride applied to all compounds. This is consistent with OEHHA's and ATSDR's approaches. DEQ proposes to keep fluorine gas separate from fluoride and compounds in terms of grouping and TRV applications even though the acute TRVs for

fluorine gas and fluoride and compounds coincidentally calculate to the same numerical values. DEQ also proposes to follow OEHHA's approach of not applying the acute TRV for "fluoride and compounds" to the aluminum sodium fluoride or sodium fluorides.

- **Sulfuric Acid and Oleum (Fuming Sulfuric Acid) (7664-93-9 and 8014-95-7):** This group includes sulfuric acid or sulfur trioxide, and "oleum" or fuming sulfuric acid. Only the acute TRV for sulfuric acid should be applied to oleum as per OEHHA's approach. This is because oleum is so reactive that a chronic exposure to it is not possible. This grouping is a new proposal for DEQ.

5. Silica (7631-86-9)

Respirable particles of silica can cause serious respiratory impairment when inhaled. The severity of health effects from inhaled silica depends on the form. In existing rule DEQ only has TRVs for one group of silica compounds, called crystalline silica. DEQ reviewed key resources to decide how to group silica compounds for this round of TRV updates:

- ATSDR Tox Profile for Silica (published September 2019)
- TCEQ documents for amorphous and other non-crystalline forms of silica (published July 2011)
- TCEQ documents for silica, crystalline forms (**24-hour**; published December 2020)
- TCEQ documents for silica, crystalline forms (published October 2009)
- OEHHA document for silica, crystalline forms chronic value (published 2005)

DEQ proposes to add a second group of silica containing compounds with a TRV. The two proposed groups are "Silica, Crystalline (respirable)" or "c-silica" and "Silica, amorphous and other non-crystalline forms (respirable)" or "a-silica." Each group has its own set of TRVs. Proposed members of the groups are:

5.1 Group 1: Silica, Crystalline Forms (Respirable) "c-Silica"

- Silica (7631-86-9)
- Cristobalite (14464-46-1)
- Flux-calcined diatomaceous earth (68855-54-9)
- Quartz (14808-60-7)
- Tridymite (15468-32-3)
- Tripoli (1317-95-9)

DEQ proposes to define c-silica as any of these listed forms of silica in the 4 microns or less size fraction. Related to this size fraction, the Texas Commission on Environmental Quality (TCEQ) states, "as with acute exposure, the chronic toxicity of silica particles is related to particle size. The key study evaluated silicosis in miners exposed to silica in the size range of 0.5-5 um. In addition, CalEPA noted that the chronic reference exposure level (REL) for silica is applicable to particles considered respirable as defined by the occupational hygiene methods described by ACGIH (**≤ 4 um**), noting that this definition differs from the typical environmental definition of respirable as particles ≤ 10 um (CalEPA 2005)" (TCEQ 2009).

5.2 Group 2: Silica, Amorphous and Other Non-Crystalline Forms (Respirable) "a-Silica"

- Fused silica or vitreous silica (60676-86-0)
- Silica fume (69012-4-2)
- Uncalcined diatomaceous earth (61790-53-2)
- Calcined diatomaceous earth (91053-39-3)

- Pyrogenic colloidal silica (112945-52-5)
- Precipitated silica (112926-00-8)
- Silica gel (63231-67-4)

DEQ proposes to define a-silica as any of these listed forms of silica in the 10 microns or less size fraction.

References

DEQ. 2023. "Compilation of ATSAC Responses to TEFs & Brominated Analogues Email on 11-1-2023." Oregon Department of Environmental Quality (DEQ). https://www.oregon.gov/deq/aq/Documents/ATSACResponsestoTEFs.pdf.

DeVito, Michael, Bas Bokkers, Majorie BM van Duursen, Karin van Ede, Mark Feeley, Elsa Antunes Fernandes Gáspár, Laurie Haws, Sean Kennedy, Richard E Peterson, and Ron Hoogenboom. 2024. "The 2022 World Health Organization Reevaluation of Human and Mammalian Toxic Equivalency Factors for Polychlorinated Dioxins, Dibenzofurans and Biphenyls." *Regulatory Toxicology and Pharmacology*. 146:105525.

EPA. 2010. "Recommended Toxicity Equivalence Factors (TEFs) for Human Health Risk Assessments of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin and Dioxin-Like Compounds." U.S. Environmental Protection Agency (EPA). https://semspub.epa.gov/work/HQ/190077.pdf.

MDH. 2016. "Guidance for Evaluating the Cancer Potency of Polycyclic Aromatic Hydrocarbon (PAH) Mixtures in Environmental Samples." Minnesota Department of Health (MDH). https://www.health.state.mn.us/communities/environment/risk/docs/guidance/pahguidance.pdf.

OEHHA. 2012. "Nickel Reference Exposure Levels." CalEPA Office of Environmental Health Hazard Assessment (OEHHA). https://oehha.ca.gov/media/downloads/crnr/032312nirelfinal.pdf.

TCEQ. 2009. "Developmental Support Document: Silica, Crystalline Forms." Texas Commission on Environmental Quality (TCEQ). https://www.tceq.texas.gov/downloads/toxicology/dsd/final/silica_crystalline_forms.pdf.

Van den Berg, Martin, Michael S Denison, Linda S Birnbaum, Michael J DeVito, Heidelore Fiedler, Jerzy Falandysz, Martin Rose, Dieter Schrenk, Stephen Safe, and Chiharu Tohyama. 2013. "Polybrominated Dibenzo-p-Dioxins, Dibenzofurans, and Biphenyls: Inclusion in the Toxicity Equivalency Factor Concept for Dioxin-like Compounds." *Toxicological Sciences* 133 (2): 197–208.

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