**Documentation of My Comparison of EPA’s PAH/POM Health Values against DEQ Toxicity Values**

**(Sue MacMillan, Sept. 17, 2021)**

**Recommendation:**

In order to keep things simple, I do not recommend trying to assign risk values to individual PAHs in the EPA PAH/POM list and the DEQ PAH list, and then summing TEF-converted values in each case to use as a tool for comparison. Instead, I recommend converting the URE value of 9.6 x 10-4 per ug/m3 in EPA’s Table 2-3 for benzo(a)pyrene (and in turn for Total PAH concentrations) to a protective concentration (i.e., toxicity value) of 0.00096 ug/m3, or 0.001 ug/m3 when rounded up. This value is approximately half of the ABC aka TRV toxicity value of 0.002 ug/m3 for benzo(a)pyrene, and in turn for Total PAH concentrations.

To demonstrate how the two protective values discussed above generate different cancer risk values, let’s say we have a concentration of 0.0064 ug/m3 of EPA PAH/POM or of DEQ Total PAHs in air:

0.0064 ug/m3 PAH/POM / 0.001 = Cancer risk of 6.4 (EPA)

0.0064 ug/m3 Total PAHs / 0.002 = Cancer risk of 3.2 (DEQ)

***Thus, I recommend that the cancer risk related to any EPA concentration based on PAH/POM in air be divided by two in order to be equivalent to the cancer risk for DEQ-generated concentrations of Total PAH in air.***

**How I Came to My Conclusions and Information Used:**

I did this work at the request of Meenakshi Rao for her NATA 2014 cancer maps created via the use of R coding. She wanted to know if the EPA cancer values for PAH/POM was similar to what DEQ has for PAHs. I told her no, and that I’d have to do some research on my own to figure out if there is some kind of proportional relationship that we can use to convert EPA risk values to DEQ-based risk values for her map.

Documents referred to:

* EPA OAQPS Technical Support Document, EPA’s 2014 National Air Toxics Assessment, 2014 NATA TSD, August 2018. Pgs 21-23.
* CAO Table 3 – Toxicity Reference Values
* Ambient Benchmark Criteria table, circa 2018

**EPA Health-Based Values (toxicity values) for PAH/POM**

For EPA’s 2014 NATA, polycyclic aromatic hydrocarbons and polycyclic organic matter (PAH/POM) were lumped together as a single group. However, the individual compounds in these groups have widely varying risks. A tabulated list of individual PAH/POM compounds is provided in Table 2.3 of the EPA TSD, based on EPA’s modeling of PAH/POM into eight separate groups by Unit Risk Estimate (URE), in units of 1/(ug/m3).

A URE is the upper-bound excess lifetime cancer risk estimated to result from continuous exposure to an agent at a concentration of 1 µg/m3 in air. The interpretation of the URE would be as follows: if the URE = 1.5 x 10-6 µg/m3, 1.5 excess tumors are expected to develop per 1,000,000 people if exposed daily for a lifetime to 1 µg of the chemical in 1 cubic meter of air. In order to convert a URE into a concentration that is protective at a one in a million or 1 x 10-6 cancer risk, the cancer risk (in decimal form of 0.000001) must be divided by the URE value. The result is a concentration in units of ug/m3 that is protective at a 10-6 cancer risk, typically referred to as a toxicity reference value, or a risk-based value.

In Table 2.3 of the EPA TSD, the final column displays the eight URE values (in units of 1/ ug/m3, or [ug/m3]-1) for the individual PAH compounds in each of the eight groups. The table below lists these eight URE values, followed by the calculated risk-based concentration that is related to a 10-6 cancer risk.

|  |  |  |
| --- | --- | --- |
| **Group** | **URE (1/[ug/m3])** | **Concentration based on 10-6 cancer risk**  **(ug/m3)** |
| 1 | 0.01 | 0.0001, or 1E-04 |
| 2 | 0.114 | 0.0000088, or 8.8E-06 |
| 3 | 9.6E-03 | 0.0001, or 1E-04 |
| 4 A | 9.6E-04 | 0.001, or 1E-03 |
| 5 | 9.6E-05 | 0.01, or 1E-02 |
| 6 | 9.6E-06 | 0.1, or 1E-01 |
| 7 | 9.9E-04 | 0.001, or 1E-03 |
| 8 | 4.8E-05 | 0.021, or 2.1E-02 |

A = Group 4 contains the PAH Benzo(a)pyrene.

Table 2.3 of the EPA TSD lists a total of 49 individual compounds or unspecified compound groupings.

**DEQ Toxicity Values for Total PAHs**

Two sets of PAH compounds are available from DEQ, and overlap the EPA PAH/POM list above to some degree:

* One set of DEQ PAHs is included in Ambient Benchmark Concentrations (ABCs) last updated in 2018. There is an ABC for Total PAHs and for 26 individual PAH compounds included in this set of values. Twenty-two (22) of these PAHs overlap with the EPA list shown in their Table 2-3.
* The other set is listed in Cleaner Air Oregon’s Table 3, which contains toxicity reference values for PAHs and for a large number of other chemicals. There is a TRV for Total PAHs, and for each of 19 individual PAH compounds. Fourteen (14) of these PAHs overlap with EPA’s Table 2-3 list.
* Note that ABCs and TRVs for PAHs provide the same toxicity values, and in fact ABCs were included as TRVs in CAO Table 3. DEQ uses ABCs to identify, evaluate, and address toxic air contaminant problems in Oregon airsheds. ABCs were developed to be air quality goals. ABCs were established prior to the Cleaner Air Oregon program. The first set of ABCs were adopted into rule in 2006. ABCs only account for risk from long-term exposures (chronic). There is only one ABC (either cancer or noncancer) per chemical, which is unlike a TRV, which may have as many as three types (chronic cancer TRV, chronic noncancer TRV, and acute noncancer TRV) for a chemical. ABC values and TRV values will be considered equivalent values, assuming that currently proposed Air Toxics Alignment Rules are adopted.
* Fourteen (14) of the PAHs listed in EPA’s Table 2-3 match PAHs related to both the ABC for Total PAHs and to the PAHs listed in CAO Table 3.
* The list of 26 PAHs related to the ABC for Total PAHs are described in DEQ’s July 2020 *Recommended Procedures for Toxic Air Contaminant Risk Assessment*, Appendix E, Table E-3.
* The 2018 ABC (0.002 ug/m3) and the CAO Table 3 TRV (0.0017 ug/m3) for Total PAHs are the same value when rounded. In both cases, the ABC and TRV for Total PAHs are based on the ABC and TRV for benzo(a)pyrene.

**How the Toxicity Equivalency Factor Methodology Relates to Total PAHs**

The toxicity equivalency factor (TEF) methodology was developed by the U.S. Environmental Protection Agency (EPA) to evaluate the toxicity and assess the risks of a mixture of structurally-related chemicals with a common mechanism of action. TEF methodology specific to mixtures of polycyclic aromatic hydrocarbons (PAHs) are used by the California EPA, the Washington Department of Ecology, and DEQ’s Cleaner Air Oregon Program. In this case, concentrations of individual PAHs can be used to calculate a concentration of Total PAHs, as explained below.

Concentrations of individual PAHs should be normalized to a concentration of the PAH benzo[a]pyrene, or BaP, using TEFs. Because BaP is more carcinogenic than most of the other PAHs, it is used as the PAH against which the toxicity/carcinogenicity of other PAHs is measured. Once this normalization is completed and the TEF results summed, the resulting toxic equivalency quotient (TEQ) concentration can be compared to the toxicity value for BaP. The list of 26 PAHs and their related TEF values shown in Table E-3, Appendix E of DEQ’s *Recommended Procedures for Toxic Air Contaminant Health Risk Assessments* (July 2020) should be used to generate a concentration for total PAHs, which can then be compared to the toxicity value for BaP. Please note that current laboratory analytical methods are available for only a subset of the PAHs shown in Table E-3. Once a concentration for Total PAHs is calculated, it can be compared to the ABC/TRV for benzo(a)pyrene to determine whether the related carcinogenic risk is acceptable or not.