MICHIGAN DEPARTMENT OF ENVIRONMENTAL QUALITY

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INTEROFFICE COMMUNICATION

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November 4, 2015

To: File for Benzo(a)pyrene and Other Carcinogenic PAHs (CAS No. 50-32-8, and others listed in Table 1)

From: Michael Depa, Air Quality Division, Toxics Unit

Subject: Screening Levels for Polycyclic Aromatic Hydrocarbons

The initial risk screening level and secondary risk screening level (SRSL) for benzo(a)pyrene (B(a)P) are 6E-4 µg/m³ and 6E-3 µg/m³, respectively. The IRSL and SRSL were derived from the inhalation unit risk (IUR) factor for B(a)P of 1.76E-3 per µg/m³ (1.1E-3 per µg/m³ multiplied by an age-dependent adjustment factor or ADAF of 1.6). Previously, the Michigan Department of Environmental Quality (MDEQ) Air Quality Division (AQD) established an IRSL and SRSL for B(a)P at 5E-4 and 5E-3 µg/m^3, respectively (based on an outdated IUR of 2.1E-3 per µg/m^3).

The IUR for B(a)P is changing at this time for two reasons:

1. To be consistent with the IUR for B(a)P and carcinogenic polycyclic aromatic hydrocarbons (PAHs) currently being used by the U.S. Environmental Protection Agency (EPA, 2011).
2. To apply an adjustment factor for early life exposures as recommended for carcinogens with a mutagenic mode of action, by EPA (2005) and the MDEQ Toxics Steering Group (TSG, 2012).

The current IRSL and SRSL were derived as follows:

IRSL = 1E-6/IUR
IRSL = 1E-6/(1.76E-3 per µg/m³)
IRSL = 6E-4 µg/m³

SRSL = 1E-5/IUR
SRSL = 1E-5/(1.76E-3 per µg/m³)
SRSL = 6E-3 µg/m³

The new IRSL and SRSL are slightly higher than the previous screening levels because the previous IUR of 2.1E-3 per µg/m³ is being replaced with the current IUR of 1.76E-3 per µg/m³. Previously, the IUR for B(a)P was based on an oral dosing study, where an oral slope factor (OSF) of 7.3 per mg/kg/day (EPA, 1992) was converted to the inhalation route by multiplying by a factor of 20m³/70kg (20m³ is the default inhalation rate of an adult and 70 kg is the default body weight of an adult). An adult-based IUR of 1.1E-3 per µg/m³ was established by California's Office of Environmental Health Hazard Assessment (OEHHA, 1993). California's IUR for B(a)P was based on an inhalation study in hamsters (Thyssen et al, 1981). U.S. EPA utilized the OEHHA IUR for B(a)P in their 2005 National-scale Air Toxics Assessment (EPA,

2011), and most recently in the residual risk assessment for petroleum refineries (EPA, 2015). In addition to changing the IUR for B(a)P, the MDEQ AQD is expanding the number of PAHs with relative potency factors based on the potency of B(a)P. This is consistent with EPA's approach (EPA, 2011, 2015) and matches the approach used by OEHHA (2015).

In 1995, the AQD started to regulate B(a)P and carcinogenic PAHs based on the recommendation of the Scientific Advisory Panel (SAP, 1995a; SAP, 1995b). The SAP recommended that the relative potency factors (RPFs) used by EPA (1993) be applied to 6 carcinogenic PAHs that cause cancer in the same way that B(a)P does. The new IUR used above to derive the IRSL and SRSL, as well as the expanded number of 15 specific PAHs established herein (see below), supersedes the approach described by EPA (1993) and confirmed by the SAP. The general method of assessing the risk of a mixture of PAHs based on their relative potency to that of B(a)P is retained. The addressing of asphalt fume PAHs was originally recommended by the SAP in 1995 and was adopted by the AQD; this approach is also being updated by the current B(a)P IUR and PEFs (Table 1).

EPA's Office of Air Quality Planning and Standards (OAQPS) published a list of quantitative dose-response values for hazardous air pollutants (HAPs), including PAHs which is a subset of the HAP listed as "polycyclic organic matter," or POM (EPA, 2014). The subset of carcinogenic PAHs, their IURs and their potency equivalency factors (PEFs) are shown in Table 1 below. PEFs and RPFs are used synonymously.

Table 1. PAH Potency Equivalency Factors (PEFs)(adapted from OEHHA, 2015)

CHEMICAL NAME	CAS NO.	IUR① 1/(µg/m^3)	IUR With ADAF② 1/(µg/m^3)	PEF③
Dibenz(a,h)anthracene	53-70-3	0.0012		1.1④
3-Methylcholanthrene	56-49-5	0.0063		5.7④
7,12-Dimethylbenz(a)anthracene	57-97-6	0.071		65④
Chrysene	218-01-9	0.000011		0.01
Indeno(1,2,3-cd)pyrene	193-39-5	0.00011		0.1
Benzo(a)anthracene	56-55-3	0.00011		0. 1
Benzo(b)fluoranthene	205-99-2	0.00011		0.1
Benzo(k)fluoranthene	207-08-9	0.00011		0.1
Benzo(j)fluoranthene	205-82-3	0.00011		0.1
5-Methylchrysene	3697-24-3	0.0011		1
Benzo(a)pyrene	50-32-8	0.0011	1.76E-3	1
Dibenzo(a,e)pyrene	192-65-4	0.0011		1
Dibenzo(a,h)pyrene	189-64-0	0.011		10
Dibenzo(a,i)pyrene	189-55-9	0.011		10
Dibenzo(a,l)pyrene	191-30-0	0.011		10
Asphalt fumes	8052-42-4	⑤		

① Inhalation Unit Risk (IUR); both U.S. EPA (2015) and OEHHA (2015) use the same IUR.
② Age Dependent Adjustment Factor; 1.6. This is used to adjust the cancer potency to account for the increased susceptibility of children to the effects of carcinogens that cause cancer by a mutagenic mode of action (EPA, 2005, 2014).
③ Potency Equivalency Factor (OEHHA, 2015) (synonymous with Relative Potency Factor; RPF)
④ Surrogate PEFs, based on ratios of IURs for Dibenz(a,h)anthracene, 3-Methylcholanthrene and 7,12-Dimethylbenz(a)anthracene to that of benzo(a)pyrene, where $PEF_i = IUR_i/$(IUR for benzo(a)pyrene)
⑤ Apply PEFs to predicted ambient impacts of individual PAHs within asphalt fumes mixture, then sum as described in Table 3.

EPA is conducting a peer review and public comment of the scientific basis for the human health hazard and dose-response assessment of B(a)P (EPA, 2013), including a potential IUR (see Table 2 below). At the same time EPA's Science Advisory Board (SAB) has published a review (EPA-SAB, 2011) of EPA's draft, "Development of a Relative Potency Factor (RPF) Approach for Polycyclic Aromatic Hydrocarbon (PAH) Mixtures" (EPA, 2010). The next steps in EPA IRIS's review process for B(a)P is an external peer review and public comment. The next steps in the review process for expanding and updating the RPFs for PAHs is for EPA's IRIS to address the comments of the SAB in a new draft. After addressing the comments, the final assessments will be posted to the EPA IRIS Web site. AQD will wait for EPA's IRIS to address the public and peer review comments on the draft B(a)P risk assessment, as well as the Science Advisory Board's comments on EPA IRIS's updated draft RPFs (EPA, 2010).

Table 2. Summary of EPA's 2013 Draft B(a)P Inhalation Unit Risk Derivation*

Tumor Sites	Combined upper respiratory and digestive tracts tumors.
Species/Sex	Male hamsters
Selected Model	Multistage Weibull
Benchmark response	10%
Benchmark concentration (mg/m^3)	0.285
POD= BMCL (mg/m^3)	0.198
Unit Risk ($(mg/m^3)^{-1}$	0.51 per mg/m^3**

*Adapted from Table 2-9. page 166 (EPA, 2013) (Thyssen et al., 1981)

** Using the draft IUR of 0.51 per mg/m^3 and applying the ADAF of 1.6 yields an IUR of 8E-4 per $\mu g/m^3$, which in turn would yield a potential IRSL of 0.001 $\mu g/m^3$ (1E-3 $\mu g/m^3$).

The method to assess B(a)P and the additional carcinogenic PAHs is illustrated below in Table 3. The combined maximum ambient impacts of all carcinogenic PAHs (as B(a)P equivalents) must be below the IRSL. The SRSL can be used in lieu of the IRSL, if appropriate, pursuant to Rule 225(2).

Table 3. Example PAH Emissions and Application of Rule 225

Pollutant	Initial Risk Screening Level ($\mu g/m^3$)	Avg. Time	Example PAI* ($\mu g/m^3$)	RPF**	Relative PAI ($\mu g/m^3$)
Benzo(a)pyrene	0.0006	annual	2.1E-5	1	2.1E-5
Benz(a)anthracene		annual	4.0E-5	0.1	4.0E-6
Benzo(b)fluoranthene		annual	5.5E-6	0.1	5.5E-7
Benzo(k)flouranthene		annual	5.5E-6	0.1	5.5E-7
Dibenzo(a,e)pyrene		annual	5.6E-6	1	5.6E-6
3-Methylcholanthrene		annual	6.2E-7	5.7	3.5E-6
Chrysene		annual	5.2E-5	0.01	5.2E-7
Dibenz(a,h)anthracene		annual	5.5E-6	1.1	6.1E-6
Indeno(1,2,3-cd)pyrene		annual	5.5E-6	0.1	5.5E-7
				Sum =	4.2E-5

* Predicted Ambient Impact, as determined by air dispersion modeling or other appropriate method.
** Relative Potency Factor (RPF); carcinogenic potency relative to benzo(a)pyrene. In this document, RPF and PEF (Potency EquivalencyFactor; OEHHA, 2015) are synonymous.

In order to determine compliance with the IRSL it is recommended that the modeled ambient air impact of the particular PAH be multiplied by the PEF (also called RPF), resulting in relative B(a)P predicted ambient impacts (PAIs; Table 3). These are then summed with all the other carcinogenic PAHs in mixture. It is noted that an alternative method would involve converting PAH emission to B(a)P equivalent emissions, prior to dispersion modeling and comparison of the combined ambient air impact to the B(a)P IRSL and SRSL.

In the example above (see Table 3), the sum of B(a)P equivalent ambient air impacts is 4.2E-5 µg/m³. Since the combined impact is less than the IRSL of 6E-4 µg/m³, the emissions comply with Rule 225(1).

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