ARCHIVE: **Revision was necessary to reflect changes in the rules and format that became effective in February 2025 Refer to VA30008.25.002 for the updated document.**

TITLE: **How to Conduct Multiple Chemical Adjustments Under the Voluntary Action Program**

DATE EFFECTIVE: March 2009

HISTORY: Update to VA30008.14.002 – Revision was necessary reflect changes in the rule citations that became effective in October 2019

KEYWORDS: Single chemical standards, multiple chemical adjustment, generic numerical standards, cumulative noncancer risk ratio, cumulative cancer risk ratio, noncancer endpoint, noncarcinogenic chemical of concern, multiple chemical generic direct-contact soil standard, risk derived standards, potable use standards, protection of ground water meeting unrestricted potable use standards.

RULE/ AUTHORITY: OAC 3745-300-08(B)(2)(b); 3745-300-08(A)(2)(b); 3745-300-08(E)

QUESTION: Is it necessary to consider the presence of multiple chemicals at a VAP Property when developing applicable standards for the Property?

ANSWER: Yes, in accordance with OAC 3745-300-08(A)(2)(b), and (B)(2)(b), the single chemical generic standards must be adjusted for the presence of multiple chemicals with the same disease endpoint (cancer or non-cancer) and within the same land use and activity category. This TGC and the example below focus on human health. Refer to Ohio EPA's Ecological Risk Assessment Guidance (See Section 2.3.5) for more information on cumulative effects for ecological receptors.

Chemicals of concern (COCs) contained in appendix A to OAC 3745-300-08 are subject to multiple chemical adjustment, with the exception of lead per OAC 3745-300-08(C)(3)(a)(v)

and those ground water COCs with maximum contaminant levels (MCLs) in Table VIII: *Generic Unrestricted Potable Use Standards Based on MCL's or Other Regulatory Established Criteria* in Table VIII of appendix A to OAC 3745-300-08 per OAC 3745-300-08(D)(3)(b) and OAC 3745-300-07(F)(3)(a)(iv). It is inappropriate to perform a multiple chemical adjustment (MCA) on the COCs contained in Table VIII of appendix A to OAC 3745-300-08 and the lead standards contained in tables I, II, III, and IV of appendix A to OAC 3745-300-08 due to factors and assumptions that were utilized in deriving these particular standards (in accordance with OAC 3745-300-08(A)(2)(a), 3745-300-08(C)(3)(a)(v), and 3745-300-08(D)(3)(b)). COCs that are demonstrated to be present at or below background in accordance with OAC 3745-300-07(H) do not need to be included in a multiple chemical adjustment. In addition, incremental risk calculated from multiple chemicals in soils, soil gas, sub-slab vapor, or indoor air is not added to the incremental risk calculated from multiple chemicals in ground water with risk-based generic unrestricted potable use standards for the purposes of determining if the provisions for protection of ground water meeting unrestricted potable use standards apply [*i.e.*, the risk for the potable use of ground water shall not be summed with the risk from exposure pathways other than potable use of ground water per OAC 3745-300-07(F)(3)(a)(iv)].

EXAMPLE:

The MCA procedures for COCs in soil are illustrated in the following example. An MCA for COCs in ground water, soil gas, sub-slab vapor, or indoor air would be performed in a similar manner.

Suppose a VAP property has a proposed residential land use scenario in which five COCs (Table 1) have been identified in the soil.

Table 1

Chemical Of Concern	On-Property Soil Conc. (mg/kg)	Generic Direct Contact Single Chemical Non-carcinogen (GDCSN) (mg/kg)	Generic Direct Contact Single Chemical Carcinogen (GDCSC) (mg/kg)	Soil Saturation Concentration (mg/kg)	Single Chemical Standard (mg/kg)
Acenaphthene	90	7,200			7,200
Anthracene	60	36,000			36,000
Benzo(a)anthracene	14		23		23
Benzo(a)pyrene	8	36	2.3		2.3

Bis(2-ethylhexyl)phthalate (BEHP)	40	2,500	780		780

First, adjust for the noncancer disease endpoint:

In accordance with OAC 3745-300-08(E)(2), the chemicals with the non-cancer endpoint are reviewed for multiple chemical adjustment. It is assumed for the purposes of this exercise that acenaphthene, anthracene, and bis(2-ethylhexyl) phthalate share a common toxic endpoint. Calculate the ratio of the site concentration to the single chemical non-carcinogen (SCNS) value (the third column of Table I in appendix A to OAC 3745-300-08) for each non-carcinogenic chemical of concern. These quotients are then summed to determine a cumulative noncancer risk ratio, as follows:

$$(90/7{,}200) + (60/36{,}000) + (40/2{,}500) = 0.03$$

Because the cumulative non-cancer risk ratio is less than or equal to 1.0, the on-property direct contact soil concentrations meet the multiple chemical standards for the non-cancer endpoint.

Alternatively, a multiple chemical standard (MCS) can be derived by dividing each single chemical non-carcinogen value by the number of noncarcinogens (*n*) identified for the particular site (*i.e.*, three at the example site):

For acenaphthene:
MCS = [7,200 mg/kg / 3] = 2,400 mg/kg

For anthracene:
MCS = [36,000 mg/kg / 3] = 12,000 mg/kg

For bis(2-ethylhexyl)phthalate:
MCS = [2,500 mg/kg / 3] = 833.33 mg/kg

Because none of the concentrations of the COCs with a non-cancer disease endpoint exceed the MCS, on-property soil concentrations meet the multiple chemical standards for the non-cancer endpoint.

Next, in accordance with OAC 3745-300-08(E)(1), the cumulative cancer risk ratio must be derived for all carcinogenic COCs (in this case benzo(a)anthracene, benzo(a)pyrene, and BHEP) on the property. The ratio of the site concentration to its single chemical carcinogenic standard (SCCS) is determined and summed for each carcinogenic COC on the property as follows:

(14⁄23) + (8⁄2.3) + (40⁄780) = 4.14

The cumulative cancer risk ratio exceeds 1.0. If the sum exceeds 1.0, one or more of the COCs must be remediated to a concentration such that the sum would be equal to 1.0.

Alternatively, a multiple chemical standard (MCS) can be derived by dividing each single chemical carcinogen value by the number of carcinogens (n) identified for the particular site (i.e., three at the example site):.

MCS = GDCSC / n

For benzo(a)anthracene:
MCS = [23 mg/kg / 3] = 7.7 mg/kg

For benzo(a)pyrene:
MCS = [2.3 mg/kg / 3] = 0.76 mg/kg

For bis(2-ethylhexyl)phthalate:
MCS = [780 mg/kg / 3] = 260 mg/kg

The MCS for each carcinogen must be developed such that the sum of the ratios of the MCS to the generic direct contact single chemical carcinogenic soil standard (GDCSC) for all carcinogens does not exceed 1.0.

When the three values for the example site are summed:

(7.7/23) + (0.76/2.3) + (260/780)

Or, (0.335) + (0.330) + (0.333) = 0.999, 1.0 when rounded to one significant digit.

Since 0.999 < 1.0, the sum of the cancer risk ratios does not exceed one, and the MCS can be used to guide remediation and develop remediation goals.

the data from the site shows that the concentration of bis(2-ethylhexyl)phthatlate, (40 mg/kg), is below the MCS of 260 mg/kg which was derived for the compound. However, the concentrations of benzo(a)anthracene and benzo(a)pyrene exceed their respective GDCSC and MCSs, thus remediation should focus on concentrations of benzo(a)anthracene and benzo(a)pyrene. If the concentrations of benzo(a)anthracene (14 mg/kg) were remediated to the derived MCS of 7.7 mg/kg, the MCS standard for benzo[a]pyrene could exceed the previously derived MCS of 0.76

mg/kg such that:

$$(7.7 /23) + (x /2.3) + (40 /780) = 1$$

Where: '*x*' is the MCS for benzo[a]pyrene. Solving for *x*, a more flexible MCS of 1.4 mg/kg is developed. If the post-remedial concentrations of bis(2-ethylhexyl)phthalate, benzo(a)anthracene and benzo(a)pyrene were 40, 7.7 and 1.4 mg/kg, respectively, benzo(a)pyrene would fail the initial derived MCS of 0.76 mg/kg, but would meet the revised 1.4 mg/kg standard calculated in the equation above because the sum of the cancer risk ratios for the three carcinogenic compounds would be less than or equal to one.

Once the multiple chemical standards for carcinogens and noncarcinogens have been determined, then each chemical must meet the lowest of the applicable values. The values for the chemicals discussed above are summarized in Table 2.

Table 2

COC	Acenaphthene	Anthracene	Benzo (a) anthracene	Benzo (a) pyrene	BHEP
Single Chemical Non-Carcinogen (mg/kg)	7,200	36,000			2,500
Multiple Chemical Noncarcinogen (mg/kg)	2,400	12,000			833.33
Single Chemical Carcinogen (mg/kg)			23	2.3	780
Multiple Chemical Carcinogen (mg/kg)			7.7	0.76	260
Property-Specific Standard (mg/kg)	2,400	12,000	7.7	1.4	40*
Initial On-Property Soil Concentration (mg/kg)	90	60	14	8	40
Post-Remedial Soil Concentration (mg/kg)	90	60	7.7	1.4	40

* The property-specific standard is 40 mg/kg due to the use of 40 mg/kg in the derivation a more flexible MCS standard for benzo(a)pyrene.

OHIO EPA CONTACT: For any questions concerning this issue, please contact the VAP central office at (614) 644-2924.