

ARCHIVE: Archived due to the 2014 rule revision. Revisions were made to the rule citations and the example calculation. Refer to VA30008.14.002 for the updated document.

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

DATE EFFECTIVE: March 2009

HISTORY: Update of VA30008.03.001 - Revision was necessary to conform to 2009 rule revisions and to clarify the guidance within the document. However, the archived versions of the guidance document remain accurate under the respective rule versions (1996 and 2002).

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(C)(2)(b); 3745-300-08(D)(2)(c); 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(B)(2)(b), (C)(2)(b), D)(2)(c), the single chemical generic standards must be adjusted for the presence of multiple chemicals with the same disease endpoint (cancer or noncancer) and within the same land use and activity category. Chemicals of concern (COCs) contained in OAC 3745-300-08, Tables I, II, III, and VI are subject to multiple chemical adjustment. It is inappropriate to perform a multiple chemical adjustment (MCA) on the COCs contained in OAC 3745-300-08 Table IV (Generic Direct-Contact Standards for Lead) and Table V (Generic Unrestricted Potable Use Standards Based on MCL's or Other Regulatory Established Criteria) due to factors and assumptions that were utilized in deriving these particular standards (in accordance with OAC 3745-300-08(C)(3)(f) and 3745-300-08(D)(2)(a)). In addition, incremental risk calculated from multiple chemicals in soils is not added to incremental risk calculated from multiple COCs listed in Table VI in ground water for the purposes of determining if the provisions for protection of ground water meeting unrestricted potable use standards apply. See OAC 3745-300-07(F)(2)(a)(iv).

EXAMPLE:

The MCA procedures for COCs in soil are illustrated in the following example. An MCA for COCs in groundwater 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 Noncarcinogens (GDSCN) (mg/kg)	Generic Direct Contact Single Chemical Carcinogens (GDCSC) (mg/kg)	Soil Saturation Concentration (mg/kg)	Single Chemical Standard (mg/kg)
Acenaphthene	90	3,500			3,500
Anthracene	60	18,000			18,000
Benzo(a)anthracene	12		11		11
Benzo(a)pyrene	8		1.1		1.1
Bis(2-ethylhexyl)phthalate (BEHP)	40	1,300	620	190	190

First, adjust for the noncancer disease endpoint:

In accordance with OAC 3745-300-08(E)(1)(b), the chemicals with the noncancer 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 noncarcinogenic (GDSCN) value (the third column of Table 1 in OAC 3745-300-08) for each noncarcinogenic chemical of concern. These quotients are then summed to determine a cumulative noncancer risk ratio, as follows:

$$(90/3,500) + (60/18,000) + (40/1,300) = 0.060$$

Because the cumulative noncancer 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 noncarcinogenic value by the number of noncarcinogens (n) identified for the particular site (i.e., three at the example site):

For acenaphthene:

$$\text{MCS} = [3,500 \text{ mg/kg} / 3] = 1,167 \text{ mg/kg}$$

For anthracene:

$$\text{MCS} = [18,000 \text{ mg/kg} / 3] = 6,000 \text{ mg/kg}$$

For bis(2-ethylhexyl)phthalate:

$$\text{MCS} = [1,300 \text{ mg/kg} / 3] = 433 \text{ mg/kg}$$

Because none of the concentrations of COCs on the Property exceed the MCS, on-property direct contact soil concentrations meet the multiple chemical standards for the non-cancer endpoint.

Next, in accordance with OAC 3745-300-08(E)(1)(a), 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 (GDCSC) is determined and summed for each carcinogenic COC on the Property as follows:

$$(12/11) + (8/1.10) + (40/620) = 8.43$$

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. 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 soil standard (GDCSC) for all carcinogens does not exceed 1.0.

An MCS value can be derived by dividing each GDCSC value by the number of carcinogens (n) identified for the particular site (i.e., three at the example site):

$$\text{MCS} = \text{GDCSC} / n$$

For benzo(a)anthracene:

$$\text{MCS} = [11 \text{ mg/kg} / 3] = 3.67 \text{ mg/kg}$$

For benzo(a)pyrene:

$$\text{MCS} = [1.10 \text{ mg/kg} / 3] = 0.367 \text{ mg/kg}$$

For bis(2-ethylhexyl)phthalate:

$$\text{MCS} = [620 \text{ mg/kg} / 3] = 207 \text{ mg/kg}$$

When these three values are summed: $(3.67/11) + (0.367/1.10) + (207/620)$

Or, $(0.333) + (0.333) + (0.333) = 0.999$, 1.0 when rounded.

Since $0.999 < 1.0$, the sum of the cancer risk ratios does not exceed one.

The data from the site shows that the concentration of bis(2-ethylhexyl)phthalate, (40 mg/kg), is below the MCS of 207 mg/kg which was derived for the compound. If the concentrations of benzo(a)anthracene were remediated to the derived MCS of 3.67 mg/kg, the MCS standard for benzo[a]pyrene could exceed the previously derived MCS of 0.367 mg/kg such that:

$$(3.67 / 11) + (x / 1.10) + (40 / 620) = 1$$

Where: 'x' is the MCS for benzo[a]pyrene. Solving for x, a more flexible MCS of 0.66 mg/kg is developed. If the post-remedial concentrations of bis(2-ethylhexyl)phthalate, benzo(a)anthracene and benzo(a)pyrene were 40, 3.67 and 0.66 mg/kg, respectively, benzo(a)pyrene would fail the initial derived MCS of 0.367 mg/kg, but would meet the revised 0.66 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: single chemical noncarcinogen standard; single chemical carcinogen standard; multiple chemical noncarcinogen standard; multiple chemical carcinogen standard; or soil saturation concentration. 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)	3,500	18,000			1,300
Multiple Chemical Noncarcinogen (mg/kg)	1,167	6,000			433
Single Chemical Carcinogen (mg/kg)			11	1.10	620
Multiple Chemical Carcinogen (mg/kg)			3.67	0.66	40
Soil Saturation Concentration (mg/kg)					190
Property-Specific Standard (mg/kg)	1,167	6,000	3.67	0.66	40*
Initial On-Property Soil Concentration (mg/kg)	90	60	12	8	40
Post-Remedial Soil Concentration (mg/kg)	90	60	3.67	0.66	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.

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CONTACT:

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