ARCHIVE: **Archived due to the 2009 rule revision. Refer to VA30008.09.002 for the updated document.**

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

DATE EFFECTIVE: January 2003

HISTORY: Update of VA30008.97.001 and VA30010.98.008 (FAQ #7) - Revision was necessary to conform to rule revisions that became effective on October 21, 2002 and to clarify the guidance within the document. However, the archived TDC document remains accurate under the 1996 VAP rules.

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)(c); 3745-300-08(D)

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)(c), (D)(1), and (D)(2), 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 environmental media (i.e., soil or groundwater) and within the same land use and activity category, for chemicals of concern (COCs) contained in OAC 3745-300-08, Tables II, III, IV, and VII. For example, if a Property has three COCs present in soil and three COCs present in groundwater, then a multiple chemical adjustment (MCA) would be appropriate for COCs in soil, and a separate MCA performed for COCs in groundwater. It is inappropriate to perform an MCA on the chemicals of concern contained in OAC 3745-300-08 Table V (Generic Direct-Contact Standards for Lead) and Table VI (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(B)(3)(f) and 3745-300-08(C)(2)(a)).

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. It is assumed for the purposes of this exercise that acenaphthene, anthracene, and bis(2-ethylhexyl) phthalate share a common toxic endpoint and/or mechanism of action.

Table 1

Chemical of Concern	On Property Direct Contact Soil Concentration (mg/kg)
Acenaphthene	90
Anthracene	60
Benzo(a)anthracene	12
Benzo(a)pyrene	8
Bis(2-ethylhexyl) phthalate (BEHP)	40

First, adjust for the noncancer disease endpoint:

In accordance with OAC 3745-300-08(D)(1)(b), the chemicals with the noncancer endpoint are reviewed for multiple chemical adjustment. Calculate the ratio of the site concentration to the Single Chemical Noncarcinogenic value (the first column of Table II 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:

$$(90/4{,}600) + (60/23{,}000) + (40/1{,}500) = 0.049$$

It is seen from the above equation that the cumulative noncancer risk ratio is less than or equal to 1.0; therefore, the on-Property direct contact soil concentrations meet the multiple chemical standards for the non-cancer endpoint.

Alternatively, a multiple chemical standard 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:
MCS = [4,600 mg/kg / 3] = 1,533 mg/kg

For anthracene:
MCS = [23,000 mg/kg / 3] = 7,667 mg/kg

For bis(2-ethylhexyl)phthalate:
MCS = [1,500 mg/kg / 3] = 500 mg/kg

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

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

(12⁄11) + (8⁄1.10) + (40⁄760) = 8.42

The cumulative cancer risk ratio exceeds 1.0. If the sum exceeds 1.0, then 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 soil standard (GCS) for all carcinogens does not exceed 1.0. Table 2 is a summary of the single chemical generic standards for the example property.

Table 2

Chemical of Concern	On-Property Direct Contact Soil Conc. (mg/kg)	Single Chemical Carcinogens (GCS) (mg/kg)	Single Chemical Noncarcinogens (GNCS) (mg/kg)	Soil Saturation Concentration (mg/kg)	Single Chemical Standard (mg/kg)
Acenaphthene	90		4,600		4,600
Anthracene	60		23,000		23,000
Benzo(a)anthracene	12	11			11
Benzo(a)pyrene	8	1.10			1.10
Bis(2-ethylhexyl) phthalate (BEHP)	40	760	1,500	230	230 *

* The single chemical standard is equal to 230 mg/kg due to the soil saturation driving the standard for this COC.

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

MCS = GCS / n

For benzo(a)anthracene:
MCS = [11 mg/kg / 3] = 3.67 mg/kg

For benzo(a)pyrene:
MCS = [1.10 mg/kg / 3] = 0.367 mg/kg

For bis(2-ethylhexyl)phthalate:
MCS = [760 mg/kg / 3] = 253 mg/kg

When these three values are summed:

(3.67/11) + (0.367/1.10) + (253/760)

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)phthatlate, (40 mg/kg), is below the MCS of 253 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 /760) = 1

Where: '*x*' is the MCS for benzo[a]pyrene. Solving for *x*, a more flexible MCS of 0.68 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 0.60 mg/kg, respectively, benzo(a)pyrene would fail the initial derived MCS of 0.367 mg/kg, but would meet the revised 0.68 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 3.

Table 3

COC	Acenapthene	Anthracene	Benzo (a) anthracene	Benzo (a) pyrene	BHEP
Single Chemical Non-Carcinogen (mg/kg)	4,600	23,000			1,500
Multiple Chemical Noncarcinogen (mg/kg)	1,533	7,667			500
Single Chemical Carcinogen (mg/kg)			11	1.10	760
Multiple Chemical Carcinogen (mg/kg)			3.67	0.68	40
Soil Saturation Concentration (mg/kg)					230
Property-Specific Standard (mg/kg)	1,533	7,667	3.67	0.68	40*
Initial On-Property Soil Concentration (mg/kg)	90	60	12	8	40
Post-Remedial Soil Concentration (mg/kg)	90	60	3.67	0.60	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.