

ARCHIVE: Archived because revisions made to VAP rules in 2002 in OAC Chapter 3745-300 necessitate revisions to this guidance and to revise and clarify the guidance within the document. However, this document is accurate under the 1996 VAP rules. Refer to VA30008.03.001 for the updated document.

TITLE: How are Multiple Chemical Adjustments Conducted under the Voluntary Action Program?

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.

RULE: Paragraph (B), Rule OAC 3745-300-08

QUESTION: Is it necessary to consider the presence of multiple chemicals at a VAP site with regard to the development of applicable standards for the property?

ANSWER: In accordance with the VAP's Generic Standards Rule, the single chemical standards must be adjusted for the presence of multiple chemicals with the same disease endpoint (cancer or noncancer).

EXAMPLE: Suppose a VAP Property, has a proposed Residential Land Use scenario, in which five Chemicals of Concern (Table 1) have been identified. 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	40

First, the adjustment for the noncancer disease endpoint:

In accordance with Paragraph (B)(2)(b)(ii) of Rule OAC 3745-300-08, the Generic Numerical Standards Rule, the chemicals with the noncancer endpoint are reviewed for multiple chemical adjustment. The ratio of the site concentration to the Single Chemical Noncarcinogens value for each noncarcinogenic chemical of concern is derived and added to determine a Cumulative Noncancer Risk Ratio, as follows:

$$(90/1900) + (60/9500) + (40/390) = 0.155$$

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 have been demonstrated to meet the multiple chemical standards for the non-cancer endpoint.

Next, in accordance with Paragraph (B)(2)(b)(i) of the Generic Numerical Standards Rule, the Cumulative Cancer Risk Ratio must be derived for all carcinogenic chemicals of concern on the property, by adding the ratio of the site concentration to its single chemical carcinogen for each chemical of concern value as follows:

$$(40/150) + (12/5.5) + (8/0.55) = 17$$

The Cumulative Cancer Risk ratio exceeds 1.0; therefore a multiple chemical generic direct-contact soil standard (MCS) must be developed for each carcinogen. These 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. If the sum exceeds 1.0, then one or more of the COCs would have to be remediated to a concentration such that the sum would be equal to 1.0. These results are summarized in Table 2.

In the following example, MCS values are derived by dividing each GCS value by the number of carcinogens (n) identified for the particular site (*i.e* three at the example site):

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

For bis(2-ethylhexyl)phthalate:
 $\text{MCS} = [150\text{mg}/\text{kg}/3] = 50 \text{ mg}/\text{kg}$

For benzo(a)anthracene:

$$\text{MCS} = [5.5 \text{ mg/kg}/3] = 1.8 \text{ mg/kg}$$

For benzo(a)pyrene:

$$\text{MCS} = [0.55\text{mg/kg}/3] = 0.18 \text{ mg/kg}$$

When these three values are summed:

$$(50/150) + (1.8/5.5) + (0.18/0.55)$$

$$\text{Or, } (0.333) + (0.327) + (0.327) = 0.987, = 1.0 \text{ when rounded}$$

Since $0.987 < 1.0$, 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 value of 50 mg/kg which was derived for the compound. If the concentrations of benzo[a]anthracene were remediated to the derived MCS of 1.8 for the compound, the MCS standard for benzo[a]pyrene could exceed the previously derived MCS of 0.18 mg kg/kg such that:

$$(40/150) + (1.8/5/5) + (x/0.55) = 1$$

Where: 'x', the MCS for benzo[a]pyrene, could be solved to equal a revised MCS of 0.22 mg/kg. Therefore, this adjustment allows a more flexible MCS standard to be developed. If the post-remedial concentrations of bis(2-ethylhexyl)phthalate, benzo[a]anthracene and benzo[a]pyrene were 40, 1.8 and 0.22 mg/kg, respectively, benzo[a]pyrene would fail the initial derived MCS of 0.18 mg/kg, but would meet the revised 0.22 mg/kg standard calculated in the equation above because the sum of the cancer risk ratios for the three carcinogenic compounds will still 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 each 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 2

Chemical of Concern	On-Property Direct Contact Soil Concentration (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		1900		1900
Anthracene	60		9500		9500
Benzo[a]anthracene	12	5.5			5.5
Benzo[a]pyrene	8	0.55			0.55
Bis(2-ethylhexyl) phthalate	40	150	390	31,0000	150

Table 3

Chemical of Concern	Single Chemical Noncarcinogen (GNCS) (mg/kg)	Multiple Chemical Noncarcinogen (GNCS) (mg/kg)	Single Chemical Carcinogen (GNCS) (mg/kg)	Multiple Chemical Carcinogen (GNCS) (mg/kg)	Soil Saturation Concentration (mg/kg)	Property-Specific Standard
Acenaphthene	1900	90*				90
Anthracene	9500	60*				60
Benzo[a]anthracene			5.5	1.8		1.8
Benzo[a]pyrene			0.55	0.22		0.22
Bis(2-ethylhexyl)phthalate	390	40*	150	40	31000	40

* This value represents the on-Property soil concentration which has been demonstrated to meet applicable standards without remediation.