APPENDIX H

EXAMPLE CALCULATIONS FOR MIXTURES

As an example, an exposure to three different substances:

Material	8-hr. Exposure (ppm)	8-hr. TWA PEL (ppm)	SAE
Substance 1	500	1,000	0.089
Substance 2	80	200	0.11
Substance 3	70	200	0.18

Using Equation 3 (from Section III.G.2.):

$$E_m = \left(\frac{C_1}{L_1} + \frac{C_2}{L_2}\right) + \cdots \left(\frac{C_n}{L_n}\right)$$

Where:

E_m is the equivalent exposure severity for the mixture
E_m should be < 1 for compliance
C is the concentration of a particular contaminant
L is the OSHA exposure limit for that substance.

$$E_m = \frac{500}{1000} + \frac{80}{200} + \frac{70}{200} = 1.25$$

Since E_m > 1 an overexposure appears to have occurred; however, the SAE for each substance also needs to be considered:

Exposure severity ratio (for each substance) (from Equation 15 from Section IV.D.5. above)

$$Y_n = \frac{C_n}{L_n}$$

Ratio each to total exposure (using Equation 16 from Section IV.D.5.)

$$R_1 = \frac{Y_1}{E_m}, \ldots R_n = \frac{Y_n}{E_m}$$

The SAEs (95% confidence) of the substances comprising the mixture can be pooled by:

Equation H-1

$$R_{st} = \sqrt{[(R_1)^2 \times (SAE_1)^2 + (R_2)^2 \times (SAE_2)^2 + \cdots (R_n)^2 \times (SAE_n)^2]}$$

which is also equivalent to (using Equation 17 from Section IV.D.5.):

$$R_{st} = \sqrt{[(R_1 \times SAE_1)^2 + (R_2 \times SAE_2)^2 + \cdots (R_n \times SAE_n)^2]}$$

From Equation 18

$$UCL = 1 + R_{St}$$

From Equation 19

$$LCL = 1 - R_{St}$$

If E_m < LCL then no overexposure has occurred at the 95% confidence level.

If LCL ≤ E_m ≤ UCL then the exposure cannot be classified as either under or over the PEL at the 95% confidence level; further sampling may be necessary.

If E_m > UCL then an overexposure has occurred (95% confidence).

Using the mixture data above:

$Y_1 = 500/1{,}000$	$Y_2 = 80/200$	$Y_3 = 70/200$
$Y_1 = 0.5$	$Y_2 = 0.4$	$Y_3 = 0.35$
$R_1 = Y_1/E_m = 0.4$	$R_2 = 0.32$	$R_3 = 0.28$

$$(R_{st})^2 = (0.4 \times 0.089)^2 + (0.32 \times 0.11)^2 + (0.28 \times 0.18)^2$$

$$R_{st} = \sqrt{(R_{st})^2} = 0.071$$

$$UCL = 1 + R_{st} = 1.071$$

$$E_m = 1.25$$

Therefore E_m > UCL and an overexposure has occurred within 95 percent confidence limit.

An executable computer program is available which will calculate a control limit for any mixture. Simply input the exposures, limits, and SAEs and the program will calculate a control limit according to the above equation.

Mixture Calculator