

Section 3360 Equations

Equation 1

$$M_f = Q_{sd} C_c [12] [0.0416] [10^{-6}]$$

where

M_f = Total organic volatile matter mass flow rate, kg/hr

Q_{sd} = volumetric flow rate of gases entering or exiting the control device, (dscm)/h

C_c = Concentration of organic compounds as carbon, ppmv

Converts volumetric flow and concentration data to a flowrate of organic volatile matter

Equation 2

$$E = \frac{M_{fi} - M_{fo}}{M_{fi}} * 100$$

where

E = Organic volatile matter control efficiency, percent

M_{fi} = Organic volatile matter mass flow rate at the inlet to the control device, kg/h

M_{fo} = Organic volatile matter mass flow rate at the outlet to the control device, kg/h

Calculates the efficiency of the test run:
(Inlet - Outlet) / Inlet

Section 3370 Equations

Equation 1a- Step by Step B1 [Each coating, as-applied]

$$C_{ahi} = \frac{[C_{hi}M_i + \sum C_{hij}M_{ij}]}{M_i + \sum M_{ij}}$$

where

C_{ahi} = Monthly average organic HAP content of coating material, i, as-applied, kg HAP / kg coating

C_{hi} = Organic HAP content of coating material, i, as purchased, kg HAP /kg coating

M_i = Mass of as-purchased coating material, i, applied in a month, kg

C_{hij} = Organic HAP content of material, j, added to as-purchased coating material, i, kg HAP /kg coating

M_{ij} = The mass of material, j, added to as-purchased coating materials, i, in a month, kg

Determines overall HAP content of final coating material by multiplying HAP content of each component by the mass of that component and dividing by total mass. Equation can be simplified by not differentiating between coating and added material (since all are added at some point):
 $C_{ahi} = \sum C_{hij}M_{ij} / \sum M_{ij}$
[Note: Equations 1b-10 can have similar simplifications]

Equation 1b- Step by Step B1 [Each coating, as-applied]

$$C_{avi} = \frac{(C_{vi}M_i + \sum C_{vij}M_{ij})}{M_i + \sum M_{ij}}$$

where

C_{ahi} = Monthly average volatile organic content of coating material, i, as-applied, kg VOC / kg coating

C_{vi} = volatile organic content of coating material, i, kg/kg

M_i = Mass of as-purchased coating material, i, applied in a month, kg

C_{vij} = volatile organic content of material, j, added as-purchased coating material, i, kg/kg

M_{ij} = The mass of material, j, added as-purchased coating materials, i, in a month, kg

Same equation as 1a except that it is used for VOC instead of HAP. Same simplification can occur. Compare to MACT limit for compliance with individual limit.

Equation 2- Step by Step B1 [Each coating, as-applied]

$$C_{asi} = \frac{(C_{si}M_i + S C_{sij}M_{ij})}{M_i + SM_{ij}}$$

where

C_{si} = Solids content of coating material, i, kg/kg

M_i = Mass of as-purchased coating material, i, applied in a month, kg

C_{sij} = Solids content of material, j, added to as-purchased coating material, i, kg/kg

M_{ij} = The mass of material, j, added to as-purchased coating materials, i, in a month, kg

Similar to Equations 1a and 1b, except that it is used for calculating overall solids content of applied material. Same simplification can occur.

Equation 3- Step by Step B1 [Each coating, as-applied]

$$H_{si} = \frac{C_{ahi}}{C_{asi}}$$

where

H_{si} = As-applied, organic HAP to solids ratio of coating material, i.

C_{ahi} = Monthly average, as-applied, organic HAP content of coating material, i, (kg)/kg

C_{asi} = Monthly average, as-applied, solids content of coating material, i, kg/kg

Divides overall HAP content by overall solids content to obtain ratio to compare to MACT limit for an individual coating

Equation 4- Step by Step B2 [Average of all coatings]

$$H_L = \frac{S M_i C_{hi} + S M_{ij} C_{hij} - M_{vret}}{S (M_i + S M_{ij})}$$

where

H_L = Monthly average, as-applied, organic HAP content of all coating materials applied, kg HAP/ kg coating

M_i = Mass of as-purchased coating material, i, applied in a month, kg

C_{hi} = Organic HAP content of coating material, i, as purchased, kg HAP /kg coating

M_{ij} = The mass of material, j, added to as-purchased coating materials, i, in a month, kg

C_{hij} = Organic HAP content of material, j, added to as-purchased coating material, i, kg HAP /kg coating

M_{vret} = Mass of volatile matter retained in the coated web after curing or drying or not otherwise emitted to the atmosphere, kg

Sums HAP contents of all coatings and all added material (mass * concentration) and divides by overall mass. Allows for facility to account for solvent retained in the web or otherwise not emitted.

Equation 5- Step by Step B2 [Average of all coatings]

$$H_s = \frac{S M_i C_{hi} + S M_{ij} C_{hij} - M_{vret}}{S M_i C_{Si} + S M_{ij} C_{Sij}}$$

where

H_s = Monthly average, as-applied, organic HAP to solids ratio of all coating materials applied, kg HAP/ kg solids

M_i = Mass of as-purchased coating material, i, applied in a month, kg

C_{hi} = Organic HAP content of coating material, i, as purchased, kg HAP /kg coating

M_{ij} = The mass of material, j, added to as-purchased coating materials, i, in a month, kg

C_{hij} = Organic HAP content of material, j, added to as-purchased coating material, i, kg HAP /kg coating

C_{Si} = Solids content of coating material, i, kg solids /kg coating

C_{Sij} = Solids content of material, j, added to as-purchased coating material, i, kg solids /kg coating

M_{vret} = Mass of volatile matter retained in the coated web after curing or drying or not otherwise emitted to the atmosphere, kg

Sums HAP contents of all coatings and all added material (mass * concentration) and divides by total solids mass. Allows for facility to account for solvent retained in the web or otherwise not emitted.

Equation 6- Step by Step B3 [Allowable HAP], G [>1 SRS, L-L mass balance], H [>1 SRS, w/CEMS], I [>1 oxidizer]

$$H_m = S M_i C_{hi} + S M_{ij} C_{hij} - M_{vret}$$

where

H_m = Total monthly organic HAP applied, kg

M_i = Mass of as-purchased coating material, i, applied in a month, kg

C_{hi} = Organic HAP content of coating material, i, as-purchased, kg/kg

M_{ij} = The mass of material, j, added to as-purchased coating materials, i, in a month, kg

C_{hij} = Organic HAP content of material, j, added to as-purchased coating material, i, kg/kg

M_{vret} = Mass of volatile matter retained in the coated web after curing or drying or not otherwise emitted to the atmosphere, kg

Multiplies content by mass applied to calculate overall emissions. Allows for consideration of solvent retained in the product.

Equation 7- Step by Step D [SRS, L-L mass balance, efficiency] and F [single control device, emission rate]

$$R_v = (100) \frac{M_{vr} + M_{vret}}{S M_i C_{vi} + S M_{ij} C_{vij}}$$

where

R_v = Organic volatile matter collection and recovery efficiency, percent

M_{vr} = Mass of volatile matter recovered in a month, kg

M_i = Mass of as-purchased coating material, i, applied in a month, kg

C_{vi} = Volatile organic content of coating material, i, kg/kg

M_{ij} = Mass of material, j, added to as-purchased coating material, i, in a month, kg

C_{vij} = Volatile organic content of material, j, added to as-purchased coating material, i, kg/kg

M_{vret} = Mass of volatile matter retained in the coated web after curing or drying or not otherwise emitted to the atmosphere, kg

Determines VOM recovery efficiency. VOM recovered or not emitted is divided by total VOM applied (based on summing coating usage and content). All solvent retained in web is treated as not emitted

Equation 8- Step by Step F [single control device, emission rate] and G [>1 SRS, L-L mass balance]

$$H_e = [1 - (R_v/100)] * [S C_{hi}M_i + S C_{hij}M_{ij} - M_{vret}]$$

where

H_e = Total monthly organic HAP emitted, kg

R_v = Organic volatile matter collection and recovery efficiency, percent

C_{hi} = Organic HAP content of coating material, i, as-purchased, kg/kg

M_i = Mass of as-purchased coating material, i, applied in a month, kg

C_{hij} = Organic HAP content of material, j, added to as-purchased coating material, i, kg/kg

M_{ij} = Mass of material, j, added to as-purchased coating material, i, in a month, kg

M_{vret} = Mass of volatile matter retained in the coated web after curing or drying or not otherwise emitted to the atmosphere, kg

Determines overall HAP emitted by applying VOM efficiency to overall HAP applied. All solvent retained in web is treated as not emitted

Equation 9- Step by Steps F [single control device, emission rate], G [>1 SRS, L-L mass balance], H [>1 SRS w/CEM], and I [>1 oxidizer]

$$L = \frac{H_e}{SC_{si}M_i + SC_{sij}M_{ij}}$$

where

L = Mass organic HAP emitted per mass of coating solids applied, kg HAP/kg solids

H_e = Total monthly organic HAP emitted, kg

C_{si} = Solids content of coating material, i, kg solids /kg coating

M_i = Mass of as-purchased coating material, i, applied in a month, kg

C_{sij} = Solids content of material, j, added to as-purchased coating material, i, kg solids /kg coating

M_{ij} = Mass of material, j, added to as-purchased coating material, i, in a month, kg

Takes results of Equation 8 (HAP emitted) and divides by the total solids applied to get **kg HAP/kg solids** value to compare to MACT limit

Equation 10- Step by Steps F [single control device, emission rate], G [>1 SRS, L-L mass balance], H [>1 SRS w/CEM], and I [>1 oxidizer]

$$S = \frac{H_e}{SM_i + S M_{ij}}$$

where

S = Mass organic HAP emitted per mass of coating material applied, kg HAP/kg coating

H_e = Total monthly organic HAP emitted, kg

M_i = Mass of as-purchased coating material, i, applied in a month, kg

M_{ij} = Mass of material, j, added to as-purchased coating material, i, in a month, kg

Takes results of Equation 8 (HAP emitted) and divides by the total mass of coatings applied to get **kg HAP/kg coating** value to compare to MACT limit

Equation 11- Step by Steps C [Oxidizer, % reduct], E [SRS w/ CEMs, overall efficiency]

$$R = \frac{(E)(CE)}{100}$$

where

R = Overall organic HAP control efficiency, percent
 E = Organic volatile matter control efficiency of the control device, percent
 CE = Organic volatile matter capture efficiency of the capture system, percent

Capture Efficiency * Control Efficiency

Equation 12 - Step by Steps F [single control device, emission rate], H [>1 SRS w/CEM], and I [>1 oxidizer]

$$H_e = [(1 - R) * SC_{ahi}M_i] - M_{vret}$$

where

H_e = Total monthly organic HAP emitted, kg
 R = Overall organic HAP control efficiency, percent
 C_{ahi} = Monthly average, as-applied, organic HAP content of coating material, i, (kg)/kg
 M_i = Mass of as-purchased coating material, i, applied in a month, kg
 M_{vret} = Mass of volatile matter retained in the coated web after curing or drying or not otherwise emitted to the atmosphere, kg

Multiplies one minus the overall control efficiency by the total HAP applied/kg coating to obtain total **kg HAP/ kg coating** to compare to MACT limit. Accounts for retained in web or otherwise not emitted.

Equation 13a- Allowable HAP- existing sources Step by Steps F [single control device, emission rate], G [>1 SRS, L-L mass balance], H [>1 SRS w/CEM], and I [>1 oxidizer]

$$H_a = 0.20 S M_i G_i C_{si} + 0.04 [S M_i (1 - G_i) + S M_{Lj}]$$

where

H_a = Monthly allowable organic HAP emissions, kg.
 M_i = Mass of as-purchased coating material, i, applied in a month, kg
 G_i = Mass fraction of each coating material, i, applied at 20 weight % or greater solids content, on as-applied basis, kg/kg
 C_{si} = Solids content of coating material, i, kg/kg
 M_{Lj} = Mass of non-solids-containing coating material, j, added to solids-containing coating materials applied at less than 20 weight % solids content, on as-applied basis, in a month, kg

Calculates allowable HAP emissions for existing affected sources based on the percent of coatings applied at less than (or equal to) 20 percent solids and the percent applied at greater than 20 percent solids

Equation 13b- Allowable HAP- new sources Step by Steps F [single control device, emission rate], G [>1 SRS, L-L mass balance], H [>1 SRS w/CEM], and I [>1 oxidizer]

$$H_a = 0.08 S M_i G_i C_{si} + 0.016 [S M_i (1 - G_i) + S M_{Lj}]$$

where

H_a = Monthly allowable organic HAP emissions, kg.
 M_i = Mass of as-purchased coating material, i, applied in a month, kg
 G_i = Mass fraction of each coating material, i, applied at 20 weight % or greater solids content, on as-applied basis, kg/kg
 C_{si} = Solids content of coating material, i, kg/kg
 M_{Lj} = Mass of non-solids-containing coating material, j, added to solids-containing coating materials applied at less than 20 weight % solids content, on as-applied basis, in a month, kg

Calculates allowable HAP emissions for new affected sources based on the percent of coatings applied at less than (or equal to) 20 percent solids and the percent applied at greater than 20 percent solids

Equation 14- Step by Step G- [>1SRS, L-L Mass Balance]

$$H_e = S M_{Ci} C_{ahi} * [1-(R_v/100)] + S M_{Bi} C_{ahi} - M_{vret}$$

where

H_e = Total monthly organic HAP emitted, kg

M_{Ci} = Sum of the mass of coating material, i, as-applied on intermittently-controlled work stations operating in controlled mode and the mass of coating material, i, as-applied on always-controlled work stations, in a month, kg

C_{ahi} = Monthly average, as-applied, organic HAP content of coating material, i, (kg)/kg

M_{Bi} = Sum of mass of coating material, i, as-applied on intermittently-controlled work stations operating in bypass mode and the mass of coating material, i, as-applied on never-controlled work stations, in a month, kg

M_{vret} = Mass of volatile matter retained in the coated web after curing or drying or not otherwise emitted to the atmosphere, kg

R_v = Organic volatile matter collection and recovery efficiency, percent.

Calculates actual HAP emissions for systems with both controlled and uncontrolled work stations/lines. Accounts for solvent retained in the web or otherwise not emitted.

Equation 15- Step by Steps H [>1 SRS w/CEM], and I [>1 oxidizer]

$$H_e = [S M_{Ci} C_{ahi} * (1-R/100)] + [S M_{Bi} C_{ahi}] - M_{vret}$$

where

H_e = Total monthly organic HAP emitted, kg

M_{Ci} = Sum of the mass of coating material, i, as-applied on intermittently-controlled work stations operating in controlled mode and the mass of coating material, i, as-applied on always-controlled work stations, in a month, kg

C_{ahi} = Monthly average, as-applied, organic HAP content of coating material, i, (kg)/kg

M_{Bi} = Sum of mass of coating material, i, as-applied on intermittently-controlled work stations operating in bypass mode and the mass of coating material, i, as-applied on never-controlled work stations, in a month, kg

R = Overall organic HAP control efficiency, percent

M_{vret} = Mass of volatile matter retained in the coated web after curing or drying or not otherwise emitted to the atmosphere, kg

Calculates actual HAP emissions for systems with both controlled and uncontrolled work stations/lines. Accounts for solvent retained in the web or otherwise not emitted.