TECHNICAL DISCUSSION OF PER CAPITA EMISSION FACTORS FOR SEVERAL AREA SOURCES OF VOLATILE ORGANIC COMPOUNDS

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OVERVIEW:

The purpose of this paper is to document the development of several per capita emission factors to be used in 1982 State Implementation Plan (SIP) Volatile Organic Compound (VOC) emissions inventories. The per. capita VOC emission factors were released to local, State, and Regional control program offices through three vehicles: (1) Final Emission Inventory Requirements For 1982 Ozone State Implementation Plans[1]; (2) Procedures For The Preparation Of Emissions Inventories, Volume I, 2nd Edition[2]; and (3) three Regional workshops.' Inventories which will use the recommended factors are to be compiled for calendar year 1980 and submitted completed to the Environmental Protection Agency by December 31, 1981. By assuring agencies that these factors are the best available, the application of uniform per capita factors in SIP VOC emission inventories can be promoted.

EMISSIONS PER CAPITA INVENTORY METHOD:

VOC emission inventory methods identify emissions from individual point sources using permit files, plant visits and questionnaires mailed to facilities. However, several emissions categories cannot readily be inventoried by point source methods. Sources such as service stations, drycleaners, cold cleaning degreasing and architectural surface coating are better inventoried collectively as area sources.

Area source inventory methods include a gamut of techniques. Considerable emphasis is placed on methods which obtain local data specific to an inventory area. Still, certain source categories remain which are difficult to inventory using solvent distribution data, and employment, and tax statistics. For the difficult to inventory source categories, emissions per capita factors have been developed using national emissions data and national population statistics.

Emissions per capita factors are relatively easy to develop. Researching several references produces emissions data on source categories of interest. The data can be segregated into two types: (1) national emissions or national consumption data from which national emissions can be derived, and (2) locally derived emissions data usually modified to a per capita factor using the local population base. National emissions are converted to a per capita factor by dividing the emissions, by the appropriate data base year national population. To compute area source emissions with the factor, multiply the inventory area population by the per capita factor which produces total emission. Then point source emissions are subtracted from total emissions to arrive at the area source emission totals for use in a VOC emissions inventory.

An alternative approach is to identify national emissions from sources which are readily identifiable using point source inventory methods and then to divide the remaining national emissions'by national population. The resulting per capita emission factor would apply to only smaller sources. Emission estimates derived with the factor would be added to point source emissions data to arrive at the total emission estimate for the particular source category.

FACTOR DATA BASE:

Several problems are inherit with emission data which hinder the designation of factors for specific source categories. First and foremost is determining which emission data should be used in developing factors. National emissions data are more representative of all national urban areas as a whole but may not be directly applicable to local conditions. Locally derived factors reflect local conditions, but may be unacceptable nationally due to being unrepresentative. A range of locally derived factors would be acceptable but is often unavailable on a nationwide basis. Thus, the tendency is to employ factors based on national emissions or consumption data.

Determining which national emissions or consumption data to use is itself a problem. The two most reliable information sets from which national emissions or consumption data can be derived are (1) documents developed for or in support of New Source Performance Standards (NSPS) and Control Techniques Guideline (CTG) documents;[4-10] and (2) End Uses Of Solvents Containing Volatile Organic Compounds.[11] These data sets differ by 0-50 percent for the four source categories that both cover. In addition, both data sets have several specific limitations in estimating solvent use. Therefore, there is considerable uncertainty over which data set is a better basis for the development of per capita factors.

"END USES"

Reference 11, referred to as "End Uses", has three major drawbacks. First, the document reports consumption of solvent by end use, not emissions data. This technicality can be side stepped by making some appropriate assumptions on solvent release to the atmosphere to estimate national emissions. The second problem is that 910 x 10^6 kg (200 x 10^6 lbs/yr) are considered unaccountable in "End Uses". TRC believes that allocating this unaccountable use to identified uses will lead to less errors in inventories. The rationale for allocation is based on the assumption that unidentified solvent consumption primarily ends up as minor components in solvent mixtures in the industrial (80 percent) and consumer/commercial (20 percent) sectors.[11] This appears to be a logical assumption which provides a solution to the problem. Lastly, "End Uses" suffers from a lack of "hard" documentation and bases most of its estimates on simple discussion with industry. However, thereport does approach solvent use by attempting to identify the end product or use of all the organic solvents produced/for use in the United States. This document also represents the most current EPA work on identifying organic solvent use.

.2 x 200 x 10^6 lb = 40.24 x 10^6 lb

CTG/NSPS Data

Control Technology Guidelines (CTG) documents and reports supporting New Source Performance Standards (NSPS) for the respective area source categories also have several advantages and drawbacks. These documents are oriented towards specific subsections of a particular industry thus allowing analysis of emissions at the subcategory level, as in the drycleaning industry. One problem, however, is that gaps in-emissions information may result from the narrow perspective of CTG/NSPS work. This is the case for graphic arts where data must be augmented with information from other sources. Another problem is that emissions data were not obtained with the idea of a closed loop mass balance. Emissions data were obtained to identify the most important sources of VOC emissions, not all VOC emissions. Third, the emissions estimates in some CTG/NSPS documents are up to 12 years old. On the other hand, CTG/NSPS documents are the result of considerable research and are a foundation of VOC regulations nationwide.

Both data bases were used in deriving per capita factors. Factors derived from CTG/NSPS data were recommended for use in four'of the six source categories. Factors derived from "End Uses" were recommended in the remaining two categories. Specific reasons on why one reference was used over another are given with each derivation.

DISCUSSION AND DERIVATION OF FACTORS:

National emissions data that are proposed for use in inventory guidance are listed in Table 1. The table lists per capita emission factors that are derived from national emissions totals, as well as a range of per capita factors included for comparison with selected values. All recommended factors are derived and compared with the data range in the discussion of this Section.

TABLE 1. VOC EMISSIONS AND PER CAPITA VOC EMISSION FACTORS FOR THE U.S.[a]

Category	Recommended Value for National Emissions x 10^6 kg/yr	kg/cap-yr	Range of Per Capita Factors kg/cap-yr
Drycleaning			
Coin-op	48	0.2,	0.1 - 0.3
Commercial	130	0.6	0.3 - 0.8
Cold cleaning degreasing	285	1.4[b]	1.3 - 1.7
Architectural surface coating	446	2.1	1.7 - 3.8
Auto refinishing	160	0.8	0.2 - 0.8
Graphic arts small facilities	75	0.4	0.3 - 0.4[c]
Consumer/commercial solvent use	618 (1362.8 x 10^6 lb)	2.9[b]	N/A[d]

TOTAL 1762 x 10^6 kg

[a] References 4 - 27.
[b] Includes adjustments to exclude compounds exempted under EPA policy.
[c] Only two values.
[d] Only one value.

The discussion and derivation of factors presented in Table 1 is organized by source categories to allow independent review of factors for each category. However, for all categories, two equations are used repetitively throughout the review and for convinence are defined here.

$$PF = \frac{E}{P} \times EAF \quad \text{(Equation 1)} \qquad PF = \frac{SC}{NP} \times AF \times RF \times EAF \quad \text{(Equation 2)}$$

Where:
- PF = Per capita factor, kg/cap-yr
- E = Emissions in kg/yr
- P = Population for area where emission estimates are applicable.
- SC = National solvent consumption, kg/yr
- NP = National population, x 10^6 people
- A??= Adjustment factor which allocates unknown consumption into identified solvent end use categories as previously discussed. For industrial categories AF = 1.13 and for consumer/commercial categories&F = 1.17.
- RF= Release factor to convert consumption data into emission data.
- EAF= Exempt compound adjustment fraction

Equation 1 employs emissions data to compute a per capita factor while Equation 2 uses national solvent consumption data.

TABLE 2. LIST OF COMPOUNDS EXEMPT FROM EPA's VOC POLICY[28,29]

Methane	Ethane
Trichlorothrifluoroethane	Methylene chloride
Trichlorofluoromethane	Dichlorodifluoromethane
Chlorodifluoromethane	Trifluoromethane
Dichlorotetrafluoroethane	Chloropentafluoroethane
1,1,1-Trichloroethane (methylchloroform)	

The adjustment factor (AF) was determined by taking an adjusted major category consumption, such as industrial uses, and dividing by the respective unadjusted major category total. The adjustment to major categories was undertaken in "End Uses" by adding 80 percent of the unknown solvent to industrial uses, or 720 x 10^6 kg and allocating 20 percent to consumer/commercial uses, or 80 x 10^6 kg (5) Equation 2 is primarily used on data extracted from "End Uses". The EAF multiplier excludes the exempt compounds listed in Table 2 and are considered nonreactive as defined by EPA's VOC policy. For most solvent use categories EAF will be equal to 1.

factors

These two equations will apply for most of the derived factors below. Where other equations are used to develop per capita factors, a note is included in the derivation discussion.

$\frac{720}{.8}$ = 900x10^6 kg, on page 2 the value given is 910x10^6 kg/yr which quantity is to be used?

This value, 80 x10^6 kg, is in error. $\frac{80}{100}x = 720 \times 10^6$ kg, $x = 900 \times 10^6$ kg

Then 20% of 900x10^6 kg = $\frac{20}{100} \cdot 900 = 180 \times 10^6$ kg

DRYCTXANING:

Recommended factors - The recommended factors were derived from data developed for CTG/NSPS documents. Emissions from perchloroethylene (perc) drycleaning plants were derived from national consumption data in Reference 20 and allocated to commercial and coin operated (coin-op) plant categories from emission rate data for typical plants contained in Reference 9. Emissions from commercial petroleum solvent drycleaning plants are derived in Reference 21 based on data in References 8 and 22 on the number of plants, clothes throughput per year, and emission rate. By Equation 1, for coin-op plants:

$$\text{Per Capita Factor (PF)} = \frac{48 \times 10^6 \text{ kg/yr}}{220 \times 10^6} = 0.2 \text{ kg/cap-yr}$$

For commercial drycleaning, Equation 1 is applied to perc and petroleum solvent (PS) emissions with summation producing a combined factor.

$$PF = \frac{Eperc + Eps}{P} = \frac{130 \times 10^6 \text{ kg/yr}}{220 \times 10^6} = 0.6 \text{ kg/cap-yr}$$

An estimated population of 220 million was used for the late 1970's, the data base time of reference. These factors were considered to be superior because the data base is recent and because emissions can be calculated separately for commercial and coin-op facilities as area sources, independent of industrial drycleaning plants which should be inventoried as point sources.[2]

Other Factors - Three additional data sources complete the range of per capita emission factors for drycleaning.

"End Uses" - A factor was calculated from national consumption data presented 'on page 1-21 of Reference 11 and a recommended population figure on page 3-23. The industrial adjustment factor (IF) of 1.13 was used to allocate unidentified solvent use. By Equation 2:

$$\text{Per Capita Factor (PF)} = \frac{290 \times 10^6 \text{ kg/yr} \times 1.13 \times 1.0 \times 1.0}{215 \times 10^6} = \frac{328}{215}$$

$$= 1.5 \text{ kg/cap-yr}$$

This factor includes solvent consumption at industrial drycleaning plants. Assuming that industry profile data in support of CTG/NSPS applies, 55 percent and 20 percent of above factor can be attributed to commercial and coin-op facilities.

$$\text{PF coin-op} = \frac{328}{215} \times 0.20 = 0.3 \text{ kg/cap-yr}$$

$$\text{PF commercial} = \frac{328}{215} \times 0.55 = 0.8 \text{ kg/cap-yr}$$

These factors include petroleum solvents and perchloroethylene but no compounds which are exempt under EPA's nonreactive policy (see Table 2) so that EAF = 1. Because little destructive emission control is practiced within the industry it was assumed that solvent emissions would equal solvent consumption, making the release factor 1.

These factors are inferior since a direct association cannot be made between solvent consumption and the commercial and coin-op dry cleaning subcategories. In addition, "End Uses" data are older (1974 and 1977) than the CTG/NSPS data (1979).

The two remaining data sets are based on local surveys in Tulsa, Oklahoma and Florida, For comparison, emissions have been allocated to commercial and coin-op subcategories applying the 55/20 splits described above,

Tulsa - Reference 12 uses Equation 1 to develop a factor for Tulsa, Oklahoma. Both the emissions and population data are 1977 base year.

$$\text{PF commerical} = \frac{1{,}183{,}000 \text{ lbs/yr}}{428{,}700} \times 0.45 \text{ kg/lb} \times 0.55 = 0.7 \text{ kg/cap-yr}$$

$$\text{PF coin-op} = \frac{1{,}183{,}000 \text{ lbs/yr}}{428{,}700} \times 0.45 \text{ kg/lb} \times 0.2 = 0.3 \text{ kg/cap-yr}$$

Florida - Reference 13 provides no calculations but rather summarizes emission data which must be manipulated to derive per capita factors. Factors are for five urban counties in Florida.

PER CAPITA FACTORS FOR SEVERAL FLORIDA COUNTIES, kg/cap-yr

Subcategory	Broward	Dade	Duval	Orange	Palm Beach
coin-op	0.1	0.2	0.2	0.3	0.1
Commercial	0.3	0.5	0.5	0.8	0.4

Reference 13 also mentions an independent survey in Duval County which produces conflicting factors of 0.4 kg/cap-yr and 0.1 kg/cap-yr for commercial and coin-op subcategories respectively.

The locally derived factors cause some concern in that they are considerably less than the recommended values of 0.8 kg/cap-yr and 0.3 kg/cap-yr for commercial and coin-op drycleaning, respectively. However, the lower Florida values may be the result of climate on clothing usage. Also, to base a national factor on data from only two regions of the county would not be sound. Thus, the larger national value is still recommended.

COLD CLEANING DEGREASING:

Recommended Factor - A CTG document, Reference 5, was used in developing a per capita emissions factor for cold cleaning degreasing. The rationale in selecting the CTG document was that it contained a breakdown of degreasing emissions by type of operation, such as vapor degreasing, cold cleaning and conveyorized degreasing. Other references did not provide a breakdown of emission by process. Emissions data are from Appendix B of Reference 5 while population is a 1974 interpolation from Statistical Abstract. Equation 2 is used to calculate a factor.

$$PF = \frac{380 \times 106 \text{ kg/yr}}{211 \times 10^6} = 1.8 \text{ kg/cap-yr}$$

However, this factor includes exempt compounds according to the breakdown on page 2-5 of the CTG document.

TABLE 3. EMISSIONS SPECIES DATA FOR COLD CLEANING DEGREASING

	Solvent Consumption 10^6 kg/yr	
	Nonexempt	Exempt
Halogenated:		
Trichloroethylene	25	
1,1,1 Trichloroethane		82
Perchcloroethylene	13	
Methylene chloride		23
Trichlorotrifluoroethane		10
	38	115
Aliphatics	222	
Aromatics		
Benzene	7	
Toluene	14	
Xylene	12	
Cyclohexane	1	
Heavy aromatics	12	-
	46	
Oxygenated		
Acetone	10	
Methy ethyl ketone	8	
Butyl	5	
Ethers	6	-
	29	
TOTALS	335	115
PERCENTAGE	75%	25%

This is incomplete ID
butyl is not a compound

Based on the species data in Table 3, nonexempt compounds are only 75 percent of the cold cleaning solvent consumption. Therefore the EAF = 0.75 and a reactive per capita factor can be calculated:

$$PF = 1.8 \times 0.75 = 1.4 \text{ kg/cap-yr}$$

This is the value which appears in Table 1 as the recommended factor for estimating cold cleaning emissions.

Other Factors - Two additional factors are derived for comparison with the CTG document based factor.

"End Uses - Reference 11 can also be used to develop a per capita factor but requires that an assumption be made. "End Uses" provides total solvent use for metal cleaning which includes all types of degreasing. On page 2-7 of Reference 5 the cold cleaning fraction of degreasing emissions is 55 percent. Assuming that this fraction applies to the solvent consumption from "End Uses" the per capita factor can then be derived from Equation 2.

$$PF = \frac{(660 \times 10^6 \text{ kg/yr}) \times 0.55 \times 1.13 \times 1.0 \times 0.75}{215 \times 10^6} = 1.4 \text{ kg/cap-yr}$$

The population is recommended by "End Uses" and the industrial apportioning adjustment factor is used. Since few facilities utilize destructive control techniques, the release factor is assumed to be 1.0. The exempt compound adjustment factor is based on the CTG species data. This factor was not recommended in that the assumption made in applying the cold cleaning fraction may not be valid. Thus, the CTG based factor is recommended over the TRC based factor.

Oklahoma Inventory - An additional approach yields another factor by combining data from Reference 5 and AP-42.[18] This method is used in the Oklahoma inventory assistance to estimate area source emission from cold cleaning operations.[14]

$PF = \frac{NU \times EF}{NP}$: Where NU is the estimated number of units in operation nationally from Reference 5, EF is the emission factor from AP-42, and NP is national population.

$$PF = \frac{1{,}220{,}000 \times 300 \text{ kg/yr}}{211 \times 10^6} = 1.7 \text{ kg/cap-yr}$$

Then the factor must be adjusted to exclude exempt compounds using the CTG species data.

$$PF = 1.7 \times 0.75 = 1.3 \text{ kg/cap-yr}$$

This approach is based on data developed in CTG documents and thus the CTG based factor is recommended over this indirectly derived factor.

ARCHITECTURAL SURFACE COATING:

Recommended Factor - A CTG draft document was used to develop a per capita factor for architectual surface coating emissions. Emissions include solvents contained in paint formulations as well as thinning and cleanup solvent associated with the use of paints. From Reference 6, page 4 and Equation 1:

$$PF = \frac{340 \times 10^6 \text{ kg/yr} + 106 \times 10^6 \text{ kg/yr}}{213 \times 10^6} = \frac{446 \times 10^6 \text{ kg/yr}}{213 \times 10^6} = 2.1 \text{ kg/cap-yr}$$

Emission tonnage is for the respective coatings and associate solvent use. Population is for 1975 from Statistical Abstract.[14]

Under the exempt compound list, no solvents used in architectural surface coatings are classified as unreactive. A list of compounds is included in Reference 6 which was‘used to derive the per capita emission factor. The list is summaried in Table 4.

TABLE 4. ORGANIC SPECIES DATA FOR ARCHITECTURAL SURFACE COATING EMISSIONS

	x 10^6 kg/yr	Percent
Aliphatic Hydrocarbons	224.7	66
Aromatics	20.3	6
Alcohols	10.7	3
Acetone	6.2	2
Methyl Ethyl Ketone (MEK)	5.1	2
Methyl Isobutly Ketone (MIBK)	4.5	1
Acetates	4.9	1
Other ketones/esters	5.9	2
Glycols	34.1	10
Glycol ethers/ether esters	21.9	6
Other miscellaneous	1.5	>1
TOTAL	340	~100

Since nonreactives are included, the exempt compound adjustment fraction (EAF) is 1.0 and the per capita factor is unchanged.

Other Factors - A number of data points are available for comparison with the recommended value.

"End Uses" - From Reference 11, using Equation 2, the following factor is derived:

$$PF = \frac{320 \times 10^6 \text{ kg/yr}}{215 \times 10^6} \times 1.17 \times 1.0 \times 1.0 = 1.7 \text{ kg}$$ &?&/cap-yr

The release factor is assumed to be one as is the exempt adjustment fraction. The apportioning factor of 1.17 for the consumer/commercial sector is used. This factor does not specify if associated solvent use is included with coating solvent use. Thus, the CTG derived factor is preferred over the ~~TRG based~~ "End Uses" factor.

California - Several values are available for California urban areas and the entire State. The State value is particularly well derived while the other values are primarily present for comparison.

Per Capita Factor	State-wide[15]	San Francisco/ Oakland[15]	San Diego[15]	LA/Orange Co.[17]
kg/cap-yr	3.0	2.9	3.8	3.2

These values are higher than the recommended factor which may be a result of a greater rate of housing construction in California relative to the rest of the country. Therefore, the recommended factor is still supported.

AUTO REFINISHING:

Recommended Factor - Limited data are available on which a per capita factor can be developed. The only data easily obtained is from the "End Uses".[11] Using Equation 2 a factor can be computed.

$$PF = \frac{160 \times 10^6 \text{ kg/yr}}{215 \times 10^6} \times 1.13 \times 1.0 = 0.8 \text{ kg/cap-yr}$$

An apportionment factor of 1.13 for the industrial sector is used. The release factor is assumed to be 1.0 since little known destructive control is-practiced in this industry.

No speciation data is presented in this reference for auto refinishing coatings but is only available for coatings in general. Thus the distribution for architectural coatings in Table 4 may be used or a breakdown can be found in Appendix A of Reference 11. Both distributions show that no exempt solvents are included in the derived emission factor. Accordingly the per capita factor is unchanged since EAF is equal to 1.

Other Factor - One other factor is presented for comparison with the recommended factor.

Florida - A per capita factor derivation based on older data in Reference 13 is shown below:

$$PF = \frac{52 \times 10^3 \text{ tons/yr} \times 2000 \text{ lb/ton} \times 0.45 \text{ kg/lb}}{215 \times 10^6} = 0.2 \text{ kg/cap-yr.}$$

This value is based on a similar data base discussed in Reference 16 and is considered an under estimate. The estimate may be affected by regional variations in automobile finish wear. Therefore the factor based on "End Uses is preferred over this factor.

GRAPHIC ARTS:

Recommended Factor - Graphic arts traditionally has been inventoried as a point source category. However, a large number of small source do exist in this category in addition to major printing plants. Thus, an area source per capita factor has been suggested. Using data developed for use in CTG/NSPS work a per capita factor for small graphic arts operations (less than 250 kg/day or 100 tons/year) was derived in Reference 26. Equation 1 was employed, however the emission input was modified to exclude major sources. National graphic arts emissions from Reference 7 are reduced by major publication and packaging emissions from References 10, 23 and 24. Non-emissions from letterpress and web offset printing are also excluded based on Reference 25. By Equation 1:

$$PF = \frac{75 \times 10^6 \text{ kg/yr}}{215 \times 10^6} = 0.4 \text{ kg/cap-yr}$$

Population used in computing the factor is assumed to be representative of the data base development period. While requiring numerous assumptions, this factor is considered superior due to the availability of industry profile data.

Other Factor - Another factor was developed and is presented for comparison. Using "End Uses"[11] a factor can be developed with Equation 2.

$$PF = \frac{270 \times 10^6 \text{ kg/yr} \times 1.13}{215 \times 10^6} = 1.4 \text{ kg/cap-yr}$$

This factor would applied to both major and minor graphic'arts sources. By applying industry profile data from the CTG/NSPS data base, the factor can be reduced to represent shall graphic arts sources for comparison with the recommended factor.

$$PF = 1.4 \times 0.2 = 0.3 \text{ kg/cap-yr}$$

An apportionment factor of 1.13 for industrial solvent use is employed with population data also from "End Uses". Speciation data in Appendix A of this report indicates that special napthas represent 98 percent of solvent used in graphic arts. Another 1 percent consists of glycol esthers. Therefore, EAF = 1.0 and the factor is-unaltered since no exempt compounds are included. This factor is not preferred due to incompatability with industrial profile data. When emission adjustments from the CTG/NSPS data are subtracted from national solvent consumption data in Reference 11, a negative emissions value results.

CONSUMER/COMMERCIAL SOLVENT:

Recommended Factor - "End Uses" provides the most comprehensive breakdown of consumer/commercial solvent. National consumpt-ion data is excerpted from page l-21 of the report.[11]

TABLE 5. NATIONWIDE CONSUMER/COMMERCIAL SOLVENT USE

USE	Nationwide Consumption kg x 10^6 yr. Unadjusted	Adjusted
Aerosol products	292	342
Household products	160	183
Toiletries	113	132
Rubbing compounds	53	62
Windshield washing	52	61
Polishes and waxes	41	48
Nonindustrial adhesives	25	29
Space deodorant	15	18
Moth control	12	16
Laundry detergent	3	4
TOTAL	765	895

$$PF = \frac{895 \times 10^6 \text{ kg/yr}}{215 \times 10^6} = 4.2 \text{ kg/cap-yr (including exempt compounds)}$$

The unadjusted column represents only identified consumption data while the adjusted column includes unidentified solvent use allocated using a factor of 1.17 which has been discussed previously. The already adjusted total emissions are then used in Equation 1 to compute a per capita factor. A release factor of 1.0 is assumed since no control of these emissions is practiced. Speciation data indicates that a considerable quantity of the factor emissions consists of exempt compounds. Using Appendix A of the report, the following breakdown can be constructed.

TABLE 6. ORGANIC SPECIES DATA FOR CONSUMER/COMMERCIAL SOLVENT USE EMISSIONS

Compound	Nationwide Consumption x 10^6 kg/yr	
	Exempt	Non-exempt
Special napthas	-	234
Fluorocarbons	74	-
Chlorocarbons	102	-
Methylene chloride	50	
Isopropanol	-	89
Ethanol	-	113
Methanol,	-	52
1,1,1-Trichloroethane	13	
MIBK	-	3
MEK	-	2
Butyl acetates	-	1
P-Dichlorobenzene	-	27
Perchloroethylene	-	3
TOTAL	239	524
PERCENTAGE	31%	69%

Since non-exempt compounds represent only 69 percent of the consumer/commercial solvent consumption, EAF is equal to 0.69. Thus, the factor must be adjusted.

$$PF = 4.2 \times 0.69 = 2.9 \text{ kg/cap-yr}$$

This factor is based on the most recent speciation data available. However, compound usage within the consumer/commercial category can rapidly change over a period of only a few years. For example, the degree of substitution of chlorinated/fluorinated hydrocarbons with parafins is unknown. Thus, while the factor is recommended for inventory use, these substitution trends must be identified.

SUMMARY:

The above derived per capita emission factors for release of organics into the atmosphere represent the best available data for area source per capita inventorying. However, while these factors are corrected for exempt

solvents, they do not reflect possible changes in substitution patterns between the mid 1970's and the present. Changes in consumption need to be identified in the future to improve the available data base. In conclusion, the factors should be used in emission inventory development as they represent an improvement over per capita factors previously recommended for use in VOC emission inventories.

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