Guidance for Calculating Maximum Hourly Toxic Air Contaminant Emission Rates
June 16, 2005

This document provides guidance on calculating maximum hourly toxic air contaminant (TAC) emission rates that will be used to evaluate the acute hazard index for a project subject to Regulation 2, Rule 5. Maximum hourly emission rates are required only for those TACs that have an acute trigger level listed in Table 2-5-1 of Regulation 2-5. Emissions shall be calculated for the project based on the maximum emitting potential of the source(s) or the maximum permitted emission level of the source(s). The calculated emission should be from routine operation or emissions that are predictable, including, but not limited to continuous and intermittent releases and predictable process upsets or leaks.

A conservative estimate of the maximum hourly TAC emission rate would be based on the maximum amount of TAC that can be emitted in a single hour. For arsenic and inorganic arsenic compounds, benzene, carbon disulfide, carbon tetrachloride, chloroform, ethylene glycol ethyl ether, ethylene glycol ethyl ether acetate and ethylene glycol methyl ether, a further refinement would be to calculate the maximum hourly emission rate based on the maximum amount of TAC emitted over the averaging period listed in Table 1 of this document. Consider, for example, a source that emits a maximum of 0.6 pounds of ethylene glycol methyl ether (EGME) in an hour, but does not operate for more than 2 hours per day. While an emission rate of 0.6 lbs/hr would exceed the acute trigger level for EGME, the emission rate for the source operating only 2 hrs/day and averaged over the 6-hour averaging period found in Table 1 for EGME, results in an hourly emission rate of 0.2 lbs/hr, which is below the acute trigger level.

$$(0.6 \text{ lbs/hr}) * (2 \text{ hours operation}) / (6 \text{ hour averaging period}) = 0.2 \text{ lbs/hr}.$$

Because some of the District's Data Forms do not require the applicant to report maximum hourly usage or activity rates, maximum one-hour emission rates may need to be estimated using maximum permitted annual throughput rates, operating times, and/or engineering judgment. For source categories that are not covered by this document, and unless you have site-specific operating time data or knowledge of the typical operating times for the source category, you may initially assume that the source operates 4 hours per day for 245 days out of the year. The maximum one-hour emission rate would be calculated as follows:

$$\text{maximum one-hour emission rate, lbs/hr} = \frac{\text{maximum annual emission, lbs/yr}}{(4 \text{ hours/day})\ (245 \text{ days/yr})}$$

For sources in which different materials are processed or used, but not concurrently, the TAC emissions should be reported for each material. The acute hazard index would be determined for the each of the materials that have TAC emissions exceeding the acute trigger level.

This document is intended to provide general guidance for several source categories. If necessary, as additional source categories are identified, they will be incorporated into this document. The evaluating engineer should consult the appropriate permit handbook chapter for the calculation methodology and accepted calculation parameters (emission factors, percent evaporative losses, etc.) that are specific to the project that he or she is evaluating. It is anticipated that the updated permit handbook chapters will eventually include direction for calculating the maximum one-hour average TAC emissions as well as guidance on the size or capacity of the equipment for which this calculation will be necessary (i.e. expected to exceed the acute trigger levels).

In the mean time, folders on the network drive at pub_data\Emissions-Max 1hr\ can be used by the engineers to post example calculations for others to see or review the work already done.

General guidance for calculating maximum hourly TAC emission rates for several source categories is provided in the following sections.

I. Combustion Sources
II. General Sources
    A. Nickel Plating
III. Semiconductor Fabrication Areas
IV. Solvent Sources
    A. Surface Coating and Solvent Cleaning Operations
    B. Graphic Arts Printing (placeholder for future work)
    C. Fiberglass Operations (placeholder for future work)
    D. Perchloroethylene Drycleaners
V. Organic Liquid Storage Tanks
VI. Gasoline Dispensing Facilities

Table 1 – Toxic Air Contaminant Acute Trigger Levels and Averaging Periods

Toxic Air Contaminant	Acute Trigger Level (pounds/hour)	Averaging Period (hours)
Acrolein [1]	4.2E-04	1
Acrylic acid	1.3E+01	1
Ammonia	7.1E+00	1
Arsenic and compounds (inorganic)	4.2E-04	4
Arsine	3.5E-01	1
Benzene	2.9E+00	6
Benzyl chloride	5.3E-01	1
Carbon disulfide	1.4E+01	6
Carbon tetrachloride (Tetrachloromethane)	4.2E+00	7
Chlorine	4.6E-01	1
Chloroform	3.3E-01	7
Chloropicrin	6.4E-02	1
Copper and compounds	2.2E-01	1
Cyanide and compounds (inorganic)	7.5E-01	1
hydrogen cyanide (hydrocyanic acid)	7.5E-01	1
Dioxane, 1,4- (1,4-diethylene dioxide)	6.6E+00	1
Epichlorohydrin (1-chloro-2,3-epoxypropane)	2.9E+00	1

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Toxic Air Contaminant	Acute Trigger Level (pounds/hour)	Averaging Period (hours)
Fluorides and compounds	5.3E-01	1
hydrogen fluoride (hydrofluoric acid)	5.3E-01	1
Formaldehyde	2.1E-01	1
Glycol ethers		1
ethylene glycol butyl ether (EGBE, 2-butoxy ethanol, butyl cellosolve)	3.1E+01	1
ethylene glycol ethyl ether (EGEE, 2-ethoxy ethanol, cellosolve)	8.2E-01	6
ethylene glycol ethyl ether acetate (EGEEA, 2-ethoxyethyl acetate, cellosolve acetate)	3.1E-01	6
ethylene glycol methyl ether (EGME, 2-methoxy ethanol, methyl cellosolve	2.1E-01	6
Hydrochloric acid (hydrogen chloride)	4.6E+00	1
Hydrogen sulfide	9.3E-02	1
Isopropyl alcohol (isopropanol)	7.1E+00	1
Mercury and compounds (inorganic)	4.0E-03	1
Mercuric chloride	4.0E-03	1
Methanol (methyl alcohol)	6.2E+01	1
Methyl bromide (bromomethane)	8.6E+00	1
Methyl chloroform (1,1,1-trichloroethane)	1.5E+02	1
Methyl ethyl ketone (MEK, 2-butanone)	2.9E+01	1
Methylene chloride (dichloromethane)	3.1E+01	1
Nickel and compounds (values also apply to:)	1.3E-02	1
nickel acetate	1.3E-02	1
nickel carbonate	1.3E-02	1
nickel carbonyl	1.3E-02	1
nickel hydroxide	1.3E-02	1
Nickelocene	1.3E-02	1
nickel oxide	1.3E-02	1
nickel refinery dust from the pyrometallurgical process	1.3E-02	1
nickel subsulfide	1.3E-02	1
Nitric acid	1.9E-01	1
Ozone	4.0E-01	1
Perchloroethylene (tetrachloroethylene)	4.4E+01	1
Phenol	1.3E+01	1
Phosgene	8.8E-03	1
Propylene oxide	6.8E+00	1
Selenium and compounds		1
hydrogen selenide	1.1E-02	1
Sodium hydroxide	1.8E-02	1
Styrene	4.6E+01	1
Sulfates	2.6E-01	1
Sulfuric acid and oleum	2.6E-01	1
sulfuric acid	2.6E-01	1
sulfur trioxide	2.6E-01	1
oleum	2.6E-01	1
Toluene	8.2E+01	1
Triethylamine	6.2E+00	1
Vanadium compounds		1

Table 1 – Toxic Air Contaminant Acute Trigger Levels and Averaging Periods		
Toxic Air Contaminant	Acute Trigger Level (pounds/hour)	Averaging Period (hours)
vanadium (fume or dust)	6.6E-02	1
vanadium pentoxide	6.6E-02	1
Vinyl chloride (chloroethylene)	4.0E+02	1
Xylenes (mixed isomers)	4.9E+01	1
m-xylene	4.9E+01	1
o-xylene	4.9E+01	1
p-xylene	4.9E+01	1

1. Acrolein is listed for information only. At this time, it is not necessary to calculate emissions for acrolein. CARB has invalidated the source test method for acrolein and the current emission factors are also invalid.

I. Combustion Sources: The maximum one-hour average TAC emissions from combustion sources should be calculated based on the maximum nameplate thermal input capacity (Btu/hr) multiplied by the appropriate toxic emission factors for combustion of the fuel(s) in question. For units with the capability of firing multiple fuels, each fuel needs to be evaluated to determine the maximum hourly emissions case.

For boilers, dryers, ovens, furnaces, afterburners, kilns, flares, and turbines, the maximum hourly thermal input may be taken from the Data Form C as supplied in the permit application. In the case of internal combustion engines, the maximum firing rate will be found on the Form ICE. For incinerators, the maximum firing rate will be based on the supplemental/baseline fuel used along with the heating value (if any) of the material being burned. Flares must be evaluated on an individual basis, based on the maximum one-hour combustion capacity of the flare (stated on the Data Form C) as a function of the toxic emissions from the pilot fuel and the flared materials. For landfill gas and digester gas flares the materials produced by the flared gas may be well known. In the case of a refinery flare, a much more intensive analysis may be necessary.

All maximum firing rates should be checked against the maximum fuel usages as reported on the respective data forms. These should be in fairly close agreement (within 1% of each other).

Emission Factors: Toxic pollutant emission factors may be obtained from vendor certifications, source tests (vendor, company, BAAQMD), CARB's California Air Toxics Emission Factor (CATEF) Database, or from AP-42. In the case of diesel compression ignition engines, there is no acute REL available for diesel PM at this time (5-2005). Until an acute REL is developed for diesel PM, there is no calculation of acute risk from diesel compression ignition engines. Also, CARB has invalidated the source test method for acrolein and the current emission factors are also invalid. Until CARB approves a source test method for acrolein and emission factors are developed using the approved source test method, it is not necessary to calculate emissions for acrolein.

I. Combustion Sources (continued):

Example Calculation:

250 kW Microturbine; TAC = Formaldehyde
Rated Heat Input: 3.05 MM Btu/hr
Emission Factor, Formaldehyde (Table 3.1-3, AP-42): 7.10E-04 lb/MM Btu
Max Hrly Emissions = (3.05 MM Btu/hr)(7.10E-04 lb/MM Btu) = 0.002 lb/hr

The acute trigger level for formaldehyde is 0.21 lb/hr, therefore, based on formaldehyde emissions only, an acute risk screen would not be required for a single microturbine. A similar analysis would need to be conducted for the other toxic air contaminants emitted from this microturbine source.

II. General Source: This section provides guidance on calculating maximum hourly TAC emission rates from miscellaneous sources that are entered into our database using Data Form G. The maximum one-hour average TAC emissions from these sources should be calculated based on the maximum operating rate (usage unit/hr) reported on the Data Form G. In cases where there may not be a practical maximum hourly emission rate for the equipment or operation, engineering judgment must be used to estimate a maximum hourly emission rate based on maximum permitted annual usage rates and source-specific operating times. For sources in which different materials are processed or used, but not concurrently, the TAC emissions should be reported for each material. The acute hazard index would be determined for the each of the materials that have TAC emissions exceeding the acute trigger level.

A. Nickel Plating: The maximum one-hour average TAC emissions from nickel plating should be calculated based on the maximum rectifier capacity specified on the Data Form G (amps), multiplied by the appropriate toxic emission factors for nickel plating added to the nickel emissions from air sparging (if used).

$$E = \underset{\text{(Plating)}}{(A)(EF)} + \underset{\text{(sparging)}}{(20)(w)(Q)}$$

E = nickel emissions, mg/hr
A = Rectifier Capacity, Amps
EF = Nickel emission factor, mg/amp-hr
W = nickel weight fraction in plating bath
Q = sparging rate, scfm

The nickel emission factor may be developed from the following method:

EF, ni plating (mg/amp-hr) = $(5E\text{-}25)(w)(S^{14.923})$
w = nickel weight fraction in plating bath
S = Bath Surface Tension, dyne/cm (typically ranges from 20-50)

II.A. Nickel Plating (continued):

Alternately, the toxic pollutant emission factors may potentially be obtained from a vendor certification, source tests (vendor, company, BAAQMD), CARB's California Air Toxics Emission Factor (CATEF) Database, or from AP-42.

Sample calculation:
w = 0.07 (7% nickel)
S = 25 dyne/cm
A = 4000 amp
Tank surface area = 10 sq ft (2 X 5)
Sparge, typical = 0.25 scfm/sq ft
Q, sparging rate: (10)(0.25) = 2.5 scfm
Sparging Emissions = (20)(0.07)(2.5) = 3.5 mg/hr = 07.71E-03 lb/hr

Emission Factor, ni plating = (5E-25)(0.07)($25^{14.923}$) = 2.54E-05 mg/a-hr
E, ni plating only = [(2.54E-05 mg/a-hr)(4000 amp)(lb/454 mg)] = 2.24E-4 lb/hr

E, ni, tot = 2.24E-04 + 7.71E-03 = 0.00793 lb/hr
The acute trigger level for nickel is 0.013, therefore in this sample case the trigger is not exceeded and no further evaluation is necessary.

III. Semiconductor Fabrication Area (FAB): In general, only the inorganic emissions from a Semiconductor Fabrication Area (FAB) may trigger an acute risk screening, and only if scrubbers are not used to abate their emissions. If scrubbers are used to abate the FAB, then the inorganic emissions are usually estimated to be negligible and unlikely to trigger any acute risk screening. Hence, in the event that a scrubber is not used, the permit engineer should request the maximum hourly emission rate for each applicable inorganic acute toxic pollutant.

It is unlikely that the applicant will trigger an acute risk screening for organic toxics, because if they were to emit the hourly trigger level of organic toxics, they would trigger Achieved-in-Practice BACT requirements which would require abatement by 90% overall controls. Because FAB operations are usually continuous operations, the permit engineer may assume a worst-case typical operating schedule of 250 days per year and 4 hours per day to estimate worst-case hourly emissions:

$$\text{Hourly Emissions} = \frac{\text{Annual Emissions (lbs/yr)}}{\text{(250 days/yr)(4 hr/day)}}$$

If the acute risk screening fails, then the permit engineer may refine the estimate more by asking for the maximum hourly usage rate of the applicable acute toxic pollutant and minimum daily operating time for its use in the FAB.

IV. Solvent Sources: This section provides guidance on calculating maximum hourly TAC emission rates from solvent sources such as surface coating operations, graphic arts printing, dryers, ovens, solvent cleaning operations, drycleaners, fiberglass operations, coating and solvent manufacture, and other operations using solvents that result in emissions of organic compounds. **If a solvent source does not trigger BACT and does not emit one of the compounds listed below in Table IV-1, the maximum one-hour emissions will not exceed an acute trigger level, and no further calculations are necessary.**

Table IV-1. Organic Compounds with Low Acute Trigger Levels

acrolein	epichlorohydrin	methyl bromide
benzyl chloride	ethylene glycol ethyl ether (EGEE or cellosolve)	Phosgene
chloroform	ethylene glycol ether acetate (EGEEA or cellosolve acetate)	propylene oxide
chloropicrin	ethylene glycol methyl ether (EGME or methyl cellosolve)	Triethylamine
1,4-dioxane	isopropyl alcohol	

If the solvent source either (a) emits one of the compounds listed in Table IV-1 or (b) triggers BACT for organic compounds, then additional calculations are necessary to determine if the acute emissions will exceed a trigger level. You must determine the maximum one-hour emission rate for each TAC based on the MSDS data, vendor specification data, laboratory analyses or source tests, and operating times.

Because applicants typically enter typical working times rather than typical source operating times on the Data Form S (see line 5), this data is unreliable for calculating maximum one-hour usage rates. The best way to determine site-specific maximum hourly usage rates is to ask the applicant to provide you with maximum daily usage rates and a minimum daily operating time for the source. Divide the maximum daily usage rate by the minimum daily operating time to obtain a maximum one-hour usage rate for the source. If the applicant provides no data or the data seems unreasonable, the maximum hourly usage rate may be conservatively estimated by dividing the maximum permitted annual usage by a minimum operating time of 2 hours per day and a minimum operating time of 245 days per year.

For sources emitting benzene, carbon tetrachloride, chloroform, ethylene glycol ethyl ether, ethylene glycol ethyl ether acetate, or ethylene glycol methyl ether, a further refinement would be to calculate the maximum hourly emission rate based on the longer averaging times listed in Table 1 of this guidance document.

Guidelines for specific solvent source categories are described in the following sections A through D.

IV. Solvent Sources (continued):

A. Surface Coating and Solvent Cleaning Operations: The general TAC emission calculation equations for surface coating and solvent cleaning operations are as follows:

$$E_{TAC} = Q * \rho * X_{TAC}$$

where:

E_{TAC} is the maximum hourly TAC emission rate, lbs/hr
Q is the maximum hourly solvent or coating usage rate, gal/hr
ρ is the solvent or coating density, lbs/gal
X_{TAC} is the mass fraction of the TAC in the solvent or coating (lb TAC/lb)

Example Calculation:

Maximum Coating Usage: 245 gal/yr
Coating Density: 10.5 lbs/gal
Cellosolve Acetate by Weight: 15%

If no information on the maximum daily usage and minimum daily operating time is available, the maximum hourly Cellosolve Acetate emission rate may be estimated, assuming operating times of 2 hr/day and 245 days/yr, as follows:

$$Q = (245 \text{ gal/yr}) / (2 \text{ hrs/day}) / (245 \text{ days/yr}) = 0.50 \text{ gal/hr}$$
$$E_{TAC} = (0.50 \text{ gal/hr}) * (10.5 \text{ lbs/gal}) * (0.15) = 0.79 \text{ lbs/hr}$$

If the applicant had indicated that the maximum daily usage is 1 gal/day and minimum daily operating time is 4 hrs/day, the maximum hourly Cellosolve Acetate emission rate may be estimated as follows:

$$Q = (1 \text{ gal/day}) / (4 \text{ hrs/day}) = 0.25 \text{ gal/hr}$$
$$E_{TAC} = (0.25 \text{ gal/hr}) * (10.5 \text{ lbs/gal}) * (0.15) = 0.39 \text{ lbs/hr}$$

Table 1 shows that Cellosolve Acetate has a 6-hour averaging period. A further refinement to the maximum hourly Cellosolve Acetate emission rate may be estimated as follows

$$E_{TAC} = (0.39 \text{ lbs/hr}) * (4 \text{ hr operating period}) / (6 \text{ hr averaging period}) = 0.26 \text{ lbs/hr}$$

The last refinement for the calculation of the maximum hourly Cellosolve Acetate emission rate results in emissions that do not exceed the acute trigger level.

IV. Solvent Sources (continued):

B. Graphic Arts Printing:

Placeholder for future work.

C. Fiberglass Operations:

Placeholder for future work.

D. Perchloroethylene Drycleaners: The acute trigger level for perchloroethylene is 44 pounds per hour. The density of perchloroethylene is 13.46 pounds/gallon. As shown below, a risk screening analysis is required only if the net PERC usage rate exceeds 3,200 gallons per year.

(44 lbs PERC/hr) * (4 hr/day) * (245 days/yr) / (13.46 lbs PERC/gal) = 3200 gal/yr

Since perchloroethylene drycleaners do not use more than 3,200 gallons per year, the acute health impacts are not significant and a risk screen for the acute hazard index is not required.

V. Organic Liquid Storage Tanks:

This section provides guidance on calculating maximum hourly TAC emission rates from fixed roof, floating roof and variable vapor space organic liquid storage tanks.

Fixed Roof Tanks: Over a one-hour period, the standing storage losses from a fixed roof tank are expected to be negligible compared to the working losses. The maximum one-hour average TAC emissions from fixed roof tanks should be calculated based on the working losses using the maximum fill rate from Data Form T, the equation for fixed roof working losses and, if necessary, the methodology for speciating pollutants found in AP-42.

Floating Roof Tanks: Over a one-hour period, the rim seal, deck fitting and deck seam losses from a floating roof tank are expected to be negligible compared to the withdrawal losses. The maximum one-hour average TAC emissions from floating roof tanks should be calculated based on the working losses using the maximum withdrawal rate from Data Form T, the equation for floating roof withdrawal losses and, if necessary, the methodology for speciating pollutants found in AP-42.

Variable Vapor Space Tanks: The maximum one-hour average TAC emissions from variable vapor space tanks should be calculated based on the filling losses using the maximum fill rate, the equation for variable vapor space filling losses and, if necessary, the methodology for speciating pollutants found in AP-42.

Example Calculation: The following example calculation shows that the benzene emission rate for an abated fixed roof tank, with a 50 bbl/hr fill rate, storing benzene would not exceed the acute trigger level.

M_V, vapor molecular weight, lbs/lbmole = 78.11
P_{VA}, vapor pressure at 20^oC, psia = 1.56

V. Organic Liquid Storage Tanks (continued):

Q, fill rate, bbl/hr = 50
K_N, turnover factor = 1
K_P, working loss product factor = 1
A, abatement efficiency = 98%
Lw, working loss, lbs/hr = $0.0010\ M_V\ P_{VA}\ Q\ K_N\ K_P\ (1 - A/100)$
= 0.0010 (78.11) (1.56) (50) (1) (1) (1 – 95/100)
= 0.3 lbs/hr of benzene emissions

Since the acute trigger level for benzene is 2.9 lbs/hr, the acute health impacts due to this source are not significant and a risk screen for the acute hazard index is not required.

VI. Gasoline Dispensing Facilities: This section provides guidance on calculating maximum hourly TAC emission rates from gasoline dispensing facilities (GDF). Over a one-hour period, the breathing, refueling and spillage losses from a GDF are expected to be negligible compared to the loading losses. The maximum one-hour average TAC emissions for GDFs should be calculated based on the loading losses. The following example calculation shows that none of the TAC emissions from a loading operation would exceed the TAC acute trigger levels.

Q, fill rate, gal/hr = 10,000
F, emission factor for loading, lbs/1000 gallons = 0.084
(from CAPCOA "Gasoline Service Station Industrywide Risk Assessment Guidelines," Nov. 1997)

Vapor Space Composition	
TAC	Wt. fraction, Y
Benzene	0.003
Toluene	0.0102
Xylene	0.0012

E, emissions, lbs/hr = (Q/1000) F Y
= (10000/1000) (0.084) Y
= 0.003 lbs/hr of benzene emissions
= 0.009 lbs/hr of toluene emissions
= 0.0001 lbs/hr of xylene emissions

Since the acute trigger level for benzene, toluene and xylene is 2.9, 82 and 49 lbs/hr, respectively, the acute health impacts from GDFs are not significant and a risk screen for the acute hazard index is not required.