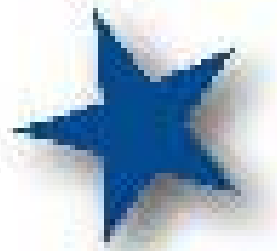
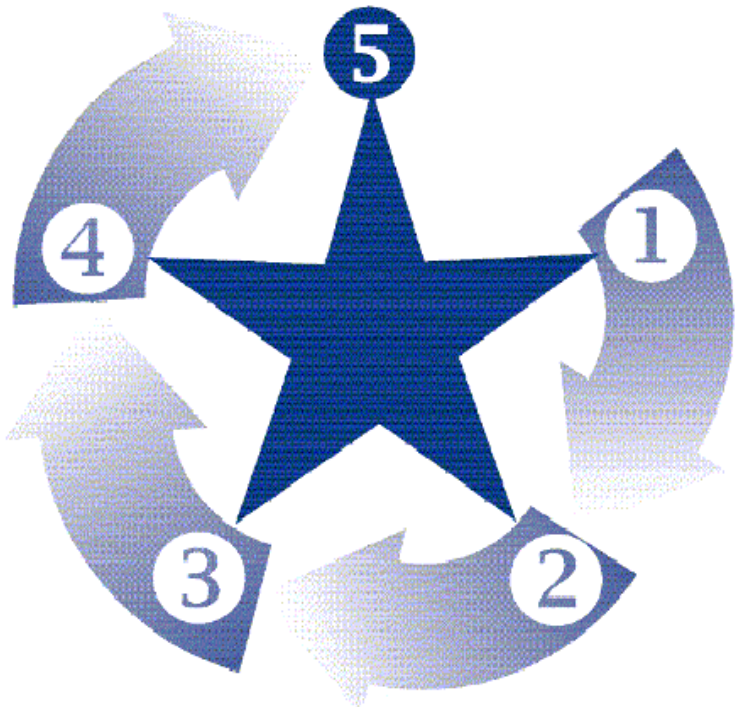


STAR Program

Strategic Toxic Air Reduction

STAR Program

Strategic Toxic Air Reduction



1. Emissions levels
2. Release points
3. Modeling ◄ ◄ ◄
4. Reduction plan
5. Compliance

“Tier 0”

BAC-based
De Minimis Emissions

“Tier 0” – De Minimis Emissions Information Required

- TACs
- BAC for each TAC (averaging period)
- Emissions: lb/hr

  lb/averaging period

4-TAC Mixture

Compound	BAC_{NC} µg/m^3	Ave. Period	BAC_C µg/m^3	Ave. Period
Toluene	400	24-hour	--	--
1,2,4-Trimethylbenzene	1230	8-hour	--	--
Xylene	100	24-hour	--	--
Methylene chloride	400	24-Hour	2.1	Annual

Toluene, 1,2,4-Trimethylbenzene, and Xylene are not carcinogens (BAC_{NC})

Methylene chloride is a carcinogen (BAC_C, also has BAC_{NC})

De Minimis – Regulation 5.01 BAC-based – Section 1.6.4

1.6.4 The emission of a TAC from a process or process equipment that is equal to or less than the amounts calculated by using the following method:

1.6.4.1 Determine the benchmark ambient concentrations - Section 4 (BAC_{NC}) and, if a carcinogen, Section 3 (BAC_C)

1.6.4.2 Multiply the BAC_{NC} (in $\mu g/m^3$) by the Tier 1 factors

1.6.4.3 Multiply the BAC_C (in $\mu g/m^3$) by the Tier 1 factors

1.6.4.4 An emission of that TAC that is less than both the smaller pound-per-hour de minimis value and the corresponding applicable averaging time period de minimis value is deemed to be a de minimis emission

The Math for Toluene

- BAC_{NC} = 400 µg/m^3, 24-Hour

Table 1

Simple Factor for Determining Maximum Ambient Concentration

BAC[1] Averaging Time	Annual Factor (F_A)[2]	24-Hour Factor (F_{24})[3]	8-Hour Factor (F_8)[4]	1-Hour Factor (F_1)[5]
Annual	480			0.54
24 hours		0.12		0.05
8 hours			0.02	0.02
1 hour				0.001

The Math for Toluene

- 400 μg/m^3 x 0.05 lb/hr / μg/m^3 = 20 lb/hr
- 400 μg/m^3 x 0.12 lb/24 hr / μg/m^3 = 48 lb/24 hr

- 48 lb/24 hr x 365 days/yr = 17,520 lb/yr (8.76 t/yr)

The Math for Methylene Chloride

- BAC_C = 2.1 µg/m^3, Annual
- BAC_{NC} = 400 µg/m^3, 24-Hour

Table 1
Simple Factor for Determining Maximum Ambient Concentration

BAC[1] Averaging Time	Annual Factor (F_A)[2]	24-Hour Factor (F_{24})[3]	8-Hour Factor (F_8)[4]	1-Hour Factor (F_1)[5]
Annual	480			0.54
24 hours		0.12		0.05
8 hours			0.02	0.02
1 hour				0.001

The Math for Methylene Chloride

Carcinogen

- 2.1 μg/m^3 x 0.54 lb/hr / μg/m^3 = 1.13 lb/hr ← ◀ ◀
- 2.1 μg/m^3 x 480 lb/yr / μg/m^3 = 1,008 lb/yr

Noncarcinogen

- 400 μg/m^3 x 0.05 lb/hr / μg/m^3 = 20 lb/hr ←
- 400 μg/m^3 x 0.12 lb/24 hr / μg/m^3 = 48 lb/24 hr

De Minimis Values

Compound	De Minimis			
	lb/hour	lb/8 hour	lb/24 hour	lb/year
Toluene	**20**		**48**	17,500
1,2,4-Trimethylbenzene	**24.6**	**24.6**		26,937
Xylene	**5**		**12**	4,380
Methylene chloride	**1.13**			**1,008**

4-TAC Mixture
Maximum Usage

- 6 gallons / hour
- 7 hours / 8-hour shift (42 gal / 8-hr) (48▼)
- 2 shifts / day (84 gal / day) (144▼)
- 5 days / week (420 gal / week) (1,008▼)
- 50 weeks / year (21,000 gal / yr) (52,560▼)

▼ (Gallons) Potential usage if not limited

4-TAC Mixture Emissions

Compound	lb/gal	De Minimis	Emissions				
			lb/hr	lb/8 hr	lb/24 hr	lb/yr	ton/yr
Toluene	**0.50**	**Yes**	**3**	21.0	**42.0**	10,500	5.25
1,2,4-Trimethylbenzene	**1.00**	**No**	**6**	**42.0**	84.0	21,000	10.50
Xylene	**1.00**	**No**	**6**	42.0	**84.0**	21,000	10.50
Methylene chloride	**0.50**	**No**	**3**	21.0	42.0	**10,500**	5.25
	3.00	**Total**	18	126	252	63,000	31.50

De Minimis Demonstration

Compound	lb/hr		lb/ave. period	
	Maximun	de minimis	Maximum	de minimis
Toluene	► 3	20	► 42	48
1,2,4-Trimethylbenzene	► 6	24.6	42	24.6
Xylene	6	5	84	12
Methylene chloride	3	1.13	10,500	1,008

Tier 1

Simple Factor Table

Tier 1 – Table 1: Simple Factor

Table 1
Simple Factor for Determining Maximum Ambient Concentration

BAC[1] Averaging Time	Annual Factor (F_A)[2]	24-Hour Factor (F_{24})[3]	8-Hour Factor (F_8)[4]	1-Hour Factor (F_1)[5]
Annual	480			0.54
24 hours		0.12		0.05
8 hours			0.02	0.02
1 hour				0.001

Tier 1 – Table 1: Simple Factor Procedure

- Step 1: Determine maximum concentration
- Step 2: If Table 1 has two factors for the averaging period, use greater max. conc.
- Step 3: Determine environmental acceptability (EA) pursuant to Reg. 5.21

Tier 1 – Table 1: Simple Factor Information Required

- TACs
- BAC for each TAC (averaging period)
- Emissions: lb/hr

  lb/Averaging Period

Tier 1 – Table 1: Simple Factor

Step 1: Determine maximum concentration

$$\text{Maximum Concentration } (\mu g/m^3) = \frac{\text{Allowed emission (lb/A.P.)}}{\text{Applicable Table 1 Factor } (\text{lb/A.P.} / \mu g/m^3)}$$

Tier 1 – Table 1: Simple Factor

Table 1
Simple Factor for Determining Maximum Ambient Concentration

BAC[1] Averaging Time	Annual Factor (F_A)[2]	24-Hour Factor (F_{24})[3]	8-Hour Factor (F_8)[4]	1-Hour Factor (F_1)[5]
Annual	480			0.54
24 hours		0.12		0.05
8 hours			0.02	0.02
1 hour				0.001

The Math for 1,2,4-Trimethylbenzene

Step 1: Maximum concentration

- 6 lb/hr ÷ 0.02 lb/hr / μg/m^3 = 300 μg/m^3
- 42 lb/8hr ÷ 0.02 lb/8hr / μg/m^3 = **2100 μg/m^3**

Step 2: Greater concentration

- **2100 μg/m^3** > 300 μg/m^3

The Math for All Four TACs

Compound	Max lb/hr	Max lb/ave P	(lb/hr) µg/m³		(lb/ave P) µg/m³	
Toluene	3	42.0	3 ÷ 0.05 =	60	42 ÷ 0.12 =	**350**
1,2,4-Trimethylbenzene	6	42.0	6 ÷ 0.02 =	300	42 ÷ 0.02 =	**2100**
Xylene	6	84.0	6 ÷ 0.05 =	120	84 ÷ 0.12 =	**700**
Methylene chloride	3	10,500	3 ÷ 0.54 =	5.6	10,500 ÷ 480 =	**21.9**

The Math for 1,2,4-Trimethylbenzene

Step 3: Demonstrate EA

- Risk = $\dfrac{\text{Maximum Concentration } (\mu g/m^3)}{\text{BAC } (\mu g/m^3)}$

$= 2100\ \mu g/m^3 \div 1230\ \mu g/m^3$

$= 1.71$ (Hazard Quotient)

Step 3
Environmental Acceptability

Compound	Max. Conc. µg/m³	BAC µg/m³	Hazard Quotient (HQ) or Risk (in 1 million) *
Toluene	350	400	350 ÷ 400 = ► **0.88**
1,2,4-Trimethylbenzene	2100	1230	2100 ÷ 1230 = **1.71**
Xylene	700	100	700 ÷ 100 = **7.00**
Methylene chloride	21.9	2.1	21.9 ÷ 2.1 = **10.43**

* EA goal for methylene chloride is 1.0 (x 10^{-6}), for other TACs EA is 0.2 HQ

Tier 2

Annual Factor Table

Tier 2 – Table 2: Annual Factor

- Step 1: Determine annual factor from Table 2
- Step 2: Determine maximum concentration
- Step 3: Determine environmental acceptability (EA) pursuant to Reg. 5.21

Tier 2 – Table 2: Annual Factor Information Required

- TACs
- BAC for each TAC (averaging period)
- Emissions: lb/hr, lb/Averaging Period
- Stack height
- Building height
- Distance to property line

Tier 2 – Table 2: Annual Factor Information Required

- TACs
- BAC for each TAC (averaging period)
- Emissions: lb/hr, lb/Averaging Period
- Stack height 52.5 Feet (1.75 Hs:Hb)
- Building height 30 Feet
- Distance to property line 250 Feet

Tier 2 – Table 2: Annual Factor

Step 1: Determine annual factor from Table 2

- Determine stack height (Hs), building height (Hb), and Hs/Hb ratio
- Determine annual factor from Table 2
  - If building height is between two columns, use lower height or interpolate
  - If Hs/Hb ratio is between two columns, use lower Hs/Hb ratio or interpolate
  - Use largest distance row that is ≤ distance to property line (do not interpolate)

Tier 2 – Table 2: Annual Factor

- Stack height (Hs) = 52.5 ft
- Building height (Hb) = 30 ft
- Hs/Hb ratio = 52.5/30 = 1.75
- Annual factor from Table 2 = 0.220

How about that interpolation part?

If Hb = 28 ft, Hs = 45 ft, Hs/Hb = 1.607, Distance = 250 ft (use 200 ft)

Distance 200 ft	**20 ft Hb**		**30 ft Hb**	
	1.25	**1.75**	**1.25**	**1.75**
	0.042	0.084	0.082	0.220

0.072 0.181

0.159

0.042+{(0.084-0.042)*[(1.607-1.25)/(1.75-1.25)]} = 0.072

0.082+{(0.220-0.082)*[(1.607-1.25)/(1.75-1.25)]} = 0.181

0.072+{(0.181-0.072)*[(28-20)/(30-20)]} = 0.159

Tier 2– Table 2: Annual Factor

Step 2: Determine maximum concentration

$$\text{Max Concentration} = \frac{\text{Allowed 1-hr emission (lb/hr)}}{\text{Table 2 Factor}^{*}}$$

($\mu g/m^3$)

(lb/hr / $\mu g/m^3$)

*** Must adjust if BAC averaging period is not annual**

Annual Factor Adjustment Factors

Averaging Period	Multiply Annual Factor:	Adjustment Factor
24-Hour	X	0.091
8-Hour	X	0.046
1-Hour	X	0.02

Adjusted Table 2 Factor

Averaging Period	Annual Factor from Table 2	Adjustment	Adjusted Factor
Annual	0.220	n/a	0.220
24-Hour	0.220	x 0.091	0.020
8-Hour	0.220	x 0.046	0.010

Allowed 1-Hour Emission Adjustment for Intermittent Emissions

- Reg. 5.22 Section 1.2 allows adjustment for average emission rate if intermittent criteria is enforceable
- Adjust 1-hour emission rate to average emission over averaging period for the BAC (assumes limitation is enforceable)

Allowed 1-Hour Emission Adjustment for Intermittent Emissions

Compound	Ave Period	Max lb/hr	Max lb/ave per	Adjusted lb/hr
Toluene	24-hr	3	42	1.75
1,2,4-Trimethylbenzene	8-hr	6	42	5.25
Xylene	24-hr	6	84	3.5
Methylene chloride	annual	3	10,500	1.20

Adjusted lb/hr is maximum allowed lb/averaging period divided by total hours in averaging period, i.e., 8 hours, 24 hours, 8760 hours

Tier 2– Table 2: Annual Factor

Step 2: Determine maximum concentration

$$\text{Max Concentration} = \frac{\text{Allowed 1-hr emission (lb/hr)}^{*}}{\text{Table 2 Factor}^{*}}$$

(µg/m^3)

(lb/hr / µg/m^3)

* Adjusted

Maximum Ambient Concentration

Compound	Ambient Concentration µg/m³	
Toluene	1.75 ÷ 0.020 =	87.5
1,2,4-Trimethylbenzene	5.25 ÷ 0.010 =	525.0
Xylene	3.5 ÷ 0.020 =	175.0
Methylene chloride	1.2 ÷ 0.220 =	5.4

Tier 2– Table 2: Annual Factor

Step 3: Demonstrate EA

- $$\text{Risk} = \frac{\text{Maximum Concentration } (\mu g/m^3)}{\text{BAC } (\mu g/m^3)}$$

Environmental Acceptability Demonstration

Compound	Ambient Conc. µg/m³	BAC µg/m³	HQ or Risk
Toluene	87.5	400	► 0.22
1,2,4-Trimethylbenzene	525.0	1230	0.43
Xylene	175.0	100	1.75
Methylene chloride	5.4	2.1	2.59

Tier 3

Screening Models

Tier 3 – Screening Models Information Required

- TACs
- BAC for each TAC (averaging period)
- Emissions: lb/hr, lb/Averaging Period
- Stack height
- Building height
- Distance to property line
- Stack airflow in acfm
- Stack gas temperature
- Stack diameter
- Building dimensions

Tier 3 – Screening Models Information Required

- TACs
- BAC for each TAC (averaging period)
- Emissions: lb/hr, lb/Averaging Period
- Stack height
- Building height
- Distance to property line
- Stack airflow in acfm
  20,000 acfm
- Stack gas temperature
  70°F
- Stack diameter
  45 inches
- Building dimensions
  100 ft by 100 ft

Tier 3 Results – SCREEN3

Compound	Ave Period	Adjusted lb/hr	Ave. Period Dilutions	Stack conc µg/m³	Amb conc µg/m³	BAC µg/m³	HQ or Risk *
Toluene	24-hr	1.75	3,145	23,363	7.4	400	► 0.02
1,2,4-Trimethylbenzene	8-hr	5.25	1,573	70,088	44.6	1230	► 0.04
Xylene	24-hr	3.5	3,145	46,725	14.9	100	► 0.15
Methylene chloride	annual	1.20	34,600	16,002	0.5	2.1	► 0.22

* EA goal for methylene chloride is 1.0 (x 10^{-6}), for other TACs EA is 0.2 HQ

Tier 4

EPA-Approved Dispersion Models

Tier 4
EPA-Approved Dispersion Models
Information Required

- TACs
- BAC for each TAC (averaging period)
- Emissions: lb/hr, lb/Averaging Period
- Stack height
- Building height
- Distance to property line
- Stack airflow in acfm
- Stack gas temperature
- Stack diameter
- Building dimensions
- Detailed plot plan
- Detailed building dimensions

Comparison of Outcomes

Compound	De Minimis	Tier 1 HQ/Risk *	Tier 2 HQ/Risk *	Tier 3 HQ/Risk *
Toluene	**Yes**	**0.88**	**0.22**	**0.02**
1,2,4-Trimethylbenzene	No	1.71	0.43	**0.04**
Xylene	No	7.00	1.75	**0.15**
Methylene chloride	No	10.43	2.59	**0.22**

* EA goal for methylene chloride is 1.0 (x 10^{-6}), for other TACs EA is 0.2 HQ