Poultry Manure Incineration Toxic Air Pollution Impacts

A Technical Report

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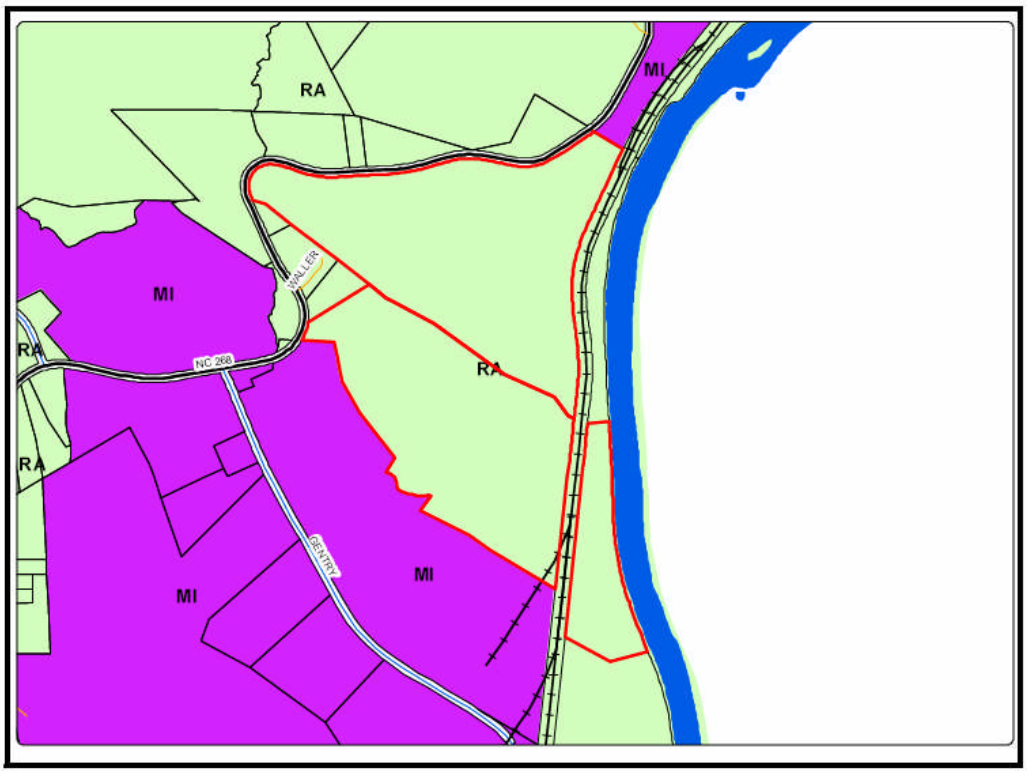
Background: Fibrowatt Picks Surry County; Surry County Approves Zoning

In June 2008, Surry County was selected by Fibrowatt LLC, as the site for a proposed poultry manure-burning power plant. The site is located along the Yadkin River east of Interstate 77 and near NC Highway 268. In February 2009, Surry County officials approved the rezoning of the site to accommodate the proposed plant. Figure A illustrates the site of the zoning change.

Figure A: Surry County Planning and Development Map[1]



The map indicates the two parcels included in the site of the re-zoning outlined in red.

BREDL Air Pollution Modeling of the Proposed Site

The facility which Blue Ridge Environmental Defense League used for the basis of this report was the Fibrominn Biomass Power Plant is located in Benson, Minnesota. The Fibrominn plant utilizes a single boiler burning primarily poultry litter for fuel. The plant has a nominal capacity of 50 megawatts of electricity, or MWe, a peak electrical capacity of 55 MW.

[1] Zoning Amendment Staff Report, Re-zoning Case No. ZCR1039, Applicant: Surry County, Tax Parcel ID Nos. 4972-00-31-8317 and 4972-00-30-8546

Pollution controls installed at the Fibrominn incinerator include a spray dryer absorber and a fabric filter baghouse to limit particulate pollution and selective non-catalytic reduction to reduce nitrogen oxides. Other major pollutants emitted by the plant include carbon monoxide, volatile organic compounds, sulfur dioxide, sulfuric acid mist, hydrogen chloride and carbon dioxide.

In addition to the major criteria pollutants, many other air pollutants designated by the federal Clean Air Act as "hazardous" are emitted by the Fibrominn plant. In North Carolina, many of these pollutants would be regulated by the state Toxic Air Pollutant program under 15A NCAC 02D .1100. North Carolina's Toxic Air Pollutant program has come under assault during the last decade, but the TAP law remains our best means for the reduction of hazardous/toxic air pollution. In this analysis, we have applied the NC TAP limits to a hypothetical poultry manure incinerating plant on the banks of the Yadkin River in Surry County plant identical to the one in Benson, Minnesota: that is, a 50 megawatt poultry manure incinerator with a 715 million BTU/hour heat input and a 300 foot tall smokestack. Figure B illustrates the site of the proposed Surry County poultry manure incinerator. Note NC Highway 268 and the Yadkin River.

Figure B: Aerial map of the proposed site east of Elkin, North Carolina.

We analyzed the proposed site using Google topographic map software. The terrain is rolling countryside.

In our analysis we employed a standard Gaussian dispersion model, the SCREEN3 to provide a generic concentration factor based on the physical characteristics of the plant

smokestack. Attachment 1 contains the detailed computer readout and Attachment 2 explains the modeling protocol. Table A lists the parameters used in the model.

Table A: Stack Parameters[2]

Emission Rate	0.126 grams/second (1 pound/hour)
Stack height	91.4 meters (300 feet)
Stack diameter:	2.7 meters(9 feet)
Stack exit velocity	25.7 m/s (84.3 ft/sec)
Stack exit temperature	421 degrees-K, (298 degrees-F)
Ambient air temperature	293 degrees-K (default 68 degrees-F)

Modeled ambient level of a given pollutant is product of:

$$C_g \times E_p \times \text{Conversion Factor} = C_m$$

Where:

C_g = generic concentration factor (µg/m3/lb/hr) from SCREEN3
E_p = pollutant emission rate (lb./hour) from permit application data
C_m = modeled pollutant concentration (µg/m3).

Conversion Factors for hourly, daily and annual pollution limits:

Hourly concentration = $C_m \times 1.0$
24-hour concentration = $C_m \times .4$
Annual concentration = $C_m \times 0.08$

Solving the equation:

$$0.2317 \times 0.012 \times 0.08 = 0.00022 \text{ micrograms/cubic meter } (2.2E\text{-}04\ \mu g/m^3)$$

Finally, the modeled pollutant concentration was compared to the state ambient limits to determine if the pollution source would be in compliance with state regulations.

Computer Modeling Results for the Surry County Site

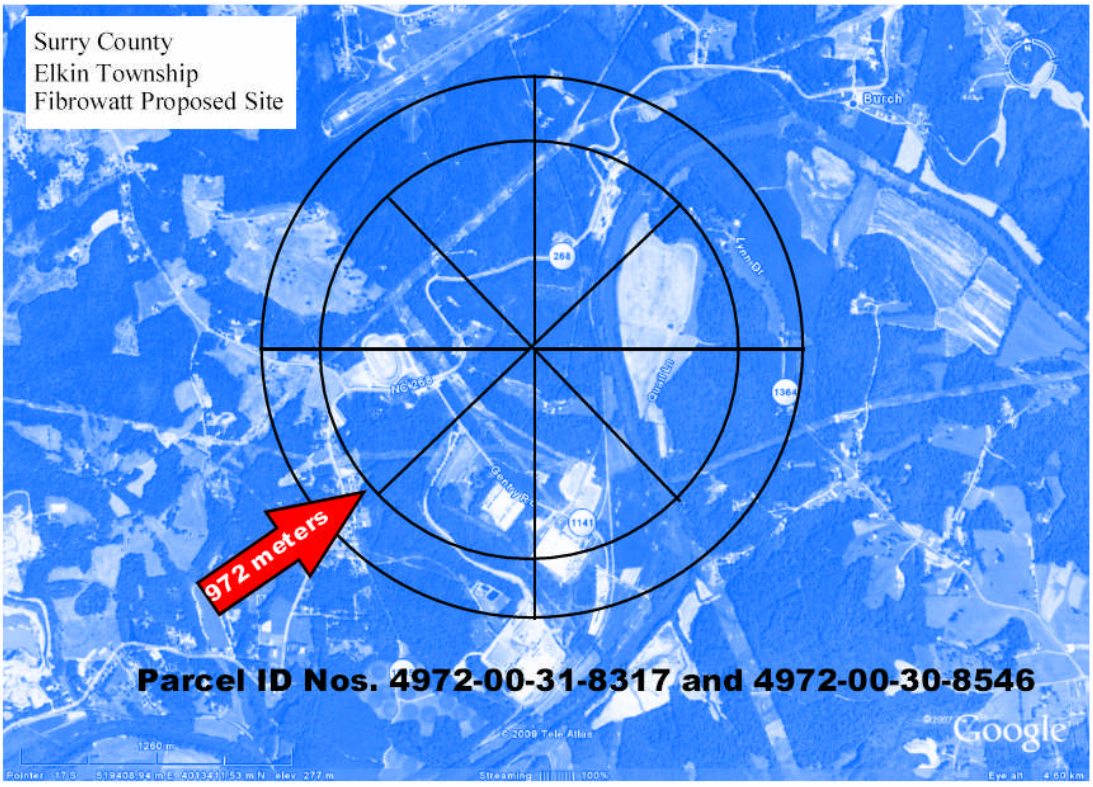
Our computer modeling predicts that a Fibrominn-type plant would exceed North Carolina toxic air pollutant limits for chromium. We calculated that chromium emissions would be 265% of the allowable NC limit. Figure C shows the extent of the pollution outside of the boundary of the re-zoned property, with the highest impacts located more than a half-mile from the proposed plant. This area would encompass many private homes and businesses surrounding the site on both sides of the river.

The modeled pollutant concentration of chromium is 0.00022 micrograms per cubic meter (2.2E-04 $\mu g/m^3$). North Carolina's highest acceptable ambient limit for chromium

[2] Stack data from Fibrominn Biomass Power Plant, Application for Re-issuance of Part 70 Permit, Eagle Mountain Scientific, Inc. Report No. 902487Hg, Table 2.1, September 3-4, 2008

is 0.000083 micrograms per cubic meter (8.3E-05 µg/m^3). The computer model indicates that the pollution leaving the smoke stack would create rising pollution levels at ground level as the poisons move downwind. The highest ambient level would be well outside property boundary at 972 meters, or six-tenths of a mile from the plant stack. It appears that the plant could not be placed within the designated property without exceeding the toxic air pollutant limit.

Figure C: Impact Zone of Toxic Air Pollutants



The North Carolina Division of Air Quality did an analysis of poultry litter incinerators and found that a Fibrominn-type plant would have trouble meeting state limits for arsenic. In fact, the DAQ's analysis revealed an annual ambient concentration of arsenic 277% of the acceptable ambient limit.[3] Both chromium and arsenic are toxic heavy metals. Both would be emitted from the smoke stack burning poultry litter.

Worst-Case Source Analysis

In addition to the SCREEN3 model, we applied the US EPA's Worst-case Spreadsheet to Fibrominn data on toxic air pollutants emissions. The worst-case method was developed by the US Environmental Protection Agency and is based upon the SCREEN3 and ISCST3 models.

[3] "NC Toxics Emissions Evaluation from Poultry/Turkey Litter," NC Environmental Management Commission Air Quality Committee, Agenda Item 13, March 11, 2009

Table 2 details the results of the worst-case analysis for each pollutant: Ammonia, Arsenic, Beryllium, Cadmium, Chromium, Hydrogen Chloride, Manganese, Mercury, Nickel and Sulfuric Acid.

Table 2: Worst-case Pollution Impacts

Toxic Air Pollutant	Molecular Weight	AAL[4] mg/m3	AAL[5] ppm	Emission rate[6] grams/sec.	**Distance Meters**
Ammonia	17.02	2.7	3.88	1.6	**500**
Arsenic	74.92	2.3E-07	7.5E-08	9.17E-04	**>10,000**
Beryllium	9.01	4.1E-06	1.1E-05	3.9E-04	**>10,000**
Cadmium	112.41	5.5E-06	1.2E-06	2.25E-04	**>10,000**
Chromium	51.99	8.3E-08	3.9E-08	1.51E-03	**>10,000**
Hydrogen Chloride (1)	36.47	0.7	0.469	3.39	**2,300**
Hydrogen Chloride(2)	17.02	0.7	0.469	*1.23*	**1,100**
Manganese	54.94	0.031	1.37E-02	8.14E-03	**300**
Mercury	200.59	0.0006	7.3E-05	8.10E-04	**900**
Nickel	58.69	0.006	2.5E-03	5.49E-03	**700**
Sulfuric Acid	98.08	0.012	2.99E-03	5.59	**>10,000**

The worst-case model predicts high levels of pollution extending up to 10 kilometers from the poultry manure incinerator. Attachment 3 contains all spreadsheets used in the worst-case analysis. Attachment 4 lists health impacts of the toxic air pollutants.

May 6, 2009

Louis A. Zeller
Science Director

[4] North Carolina Toxic Air Pollutant Guidelines, 15A NCAC 02D .1104
[5] Milligrams per cubic meter divided by molecular weight times 24.45 = parts per million (ppm)
[6] Emissions Data from: Application for PSD Permit to Construct and Federal Part 70 Permit to Operate for the Fibrominn Biomass Power Plant, Benson, MN, August 28, 2001

ATTACHMENT 1

```
******  SCREEN3 MODEL  ******
 **** VERSION DATED 95250 ****

ENTER TITLE FOR THIS RUN (UP TO 79 CHARACTERS):
Surry Fibrowatt 090430A

ENTER SOURCE TYPE: P    FOR POINT
                   F    FOR FLARE
                   A    FOR AREA
                   V    FOR VOLUME
p
ENTER EMISSION RATE (G/S):
0.126
ENTER STACK HEIGHT (M):
91.4
ENTER STACK INSIDE DIAMETER (M):
2.7
ENTER STACK GAS EXIT VELOCITY OR FLOW RATE:
OPTION 1 : EXIT VELOCITY (M/S):
 DEFAULT - ENTER NUMBER ONLY
OPTION 2 : VOLUME FLOW RATE (M**3/S):
        EXAMPLE "VM=20.00"
OPTION 3 : VOLUME FLOW RATE (ACFM):
        EXAMPLE "VF=1000.00"
25.7
ENTER STACK GAS EXIT TEMPERATURE (K):
421
ENTER AMBIENT AIR TEMPERATURE (USE 293 FOR DEFAULT) (K):
293
ENTER RECEPTOR HEIGHT ABOVE GROUND (FOR FLAGPOLE RECEPTOR)
(M):
2
ENTER URBAN/RURAL OPTION (U=URBAN, R=RURAL):
r
CONSIDER BUILDING DOWNWASH IN CALCS?  ENTER Y OR N:
n
USE COMPLEX TERRAIN SCREEN FOR TERRAIN ABOVE STACK HEIGHT?
ENTER Y OR N:
n
USE SIMPLE TERRAIN SCREEN WITH TERRAIN ABOVE STACK BASE?
ENTER Y OR N:
y
ENTER CHOICE OF METEOROLOGY;
```

1 - FULL METEOROLOGY (ALL STABILITIES & WIND SPEEDS)
2 - INPUT SINGLE STABILITY CLASS
3 - INPUT SINGLE STABILITY CLASS AND WIND SPEED
1
USE AUTOMATED DISTANCE ARRAY? ENTER Y OR N:
y
ENTER TERRAIN HEIGHT ABOVE STACK BASE (M):
20
ENTER MIN AND MAX DISTANCES TO USE (M):
300
1260
****

*** TERRAIN HEIGHT OF 20. M ABOVE STACK BASE USED FOR FOLLOWING DISTANCES ***

DIST (M)	CONC (UG/M**3)	STAB	U10M (M/S)	USTK (M/S)	MIX HT (M)	PLUME HT (M)	SIGMA Y (M)	SIGMA Z (M)	DWASH
300.	.7006E-05	1	3.0	3.5	960.0	285.42	77.92	56.32	NO
400.	.2516E-02	1	3.0	3.5	960.0	285.42	99.73	80.10	NO
500.	.3458E-01	1	3.0	3.5	960.0	285.42	120.82	113.01	NO
600.	.1050	1	3.0	3.5	960.0	285.42	141.34	161.30	NO
700.	.1390	1	3.0	3.5	960.0	285.42	161.39	219.91	NO
800.	.1897	1	1.5	1.8	500.4	499.44	207.36	306.12	NO
900.	.2256	1	1.5	1.8	500.4	499.44	226.11	383.17	NO
1000.	.2310	1	1.5	1.8	500.4	499.44	241.90	470.04	NO
1100.	.2217	1	1.5	1.8	500.4	499.44	257.84	568.60	NO
1200.	.2094	1	1.5	1.8	500.4	499.44	273.88	678.70	NO

ITERATING TO FIND MAXIMUM CONCENTRATION . . .

MAXIMUM 1-HR CONCENTRATION AT OR BEYOND 300. M:

972.	.2317	1	1.5	1.8	500.4	499.44	237.62	445.42	NO

CONTINUE SIMPLE TERRAIN AUTOMATED CALCS WITH NEW TERRAIN HEIGHT?
ENTER Y OR N:
n

USE DISCRETE DISTANCES? ENTER Y OR N:
n

DO YOU WISH TO MAKE A FUMIGATION CALCULATION? ENTER Y OR N:
n

```
    ************************************
    *** SUMMARY OF SCREEN MODEL RESULTS ***
    ************************************

 CALCULATION      MAX CONC   DIST TO  TERRAIN
  PROCEDURE      (UG/M**3)   MAX (M)   HT (M)
-------------- ------------ ------- -------
SIMPLE TERRAIN    .2317         972.      20.


**************************************************
** REMEMBER TO INCLUDE BACKGROUND CONCENTRATIONS **
**************************************************

DO YOU WANT TO PRINT A HARDCOPY OF THE RESULTS?  ENTER Y OR N:
```

ATTACHMENT 2

AIR MODELING PROTOCOL FOR THIS REPORT

We utilized the US Environmental Protection Agency's SCREEN3 Model in our calculations. The model estimates pollution concentrations from air pollution sources under a wide range of meteorological conditions. SCREEN is a Gaussian plume dispersion model which takes into account the physical factors of each particular air pollution source including emission rate, stack height and diameter, and gas exit velocity and temperature. The model can calculate pollution concentrations from a particular source at discrete distances downwind from an emission point. The EPA Technology Transfer Network Support Center for Regulatory Atmospheric Modeling states:

> Dispersion modeling uses mathematical formulations to characterize the atmospheric processes that disperse a pollutant emitted by a source. Based on emissions and meteorological inputs, a dispersion model can be used to predict concentrations at selected downwind receptor locations. These air quality models are used to determine compliance with National Ambient Air Quality Standards (NAAQS), and other regulatory requirements such as New Source Review (NSR) and Prevention of Significant Deterioration (PSD) regulations. These models are addressed in Appendix A of EPA's *Guideline on Air Quality Models* (also published as Appendix W of 40 CFR Part 51), which was originally published in April 1978 to provide consistency and equity in the use of modeling within the U.S. air quality management system.

The SCREEN3 equation for determining ground-level pollution concentration is:

$$X = Q/(2u_s yz)\ \{\exp[-\tfrac{1}{2}((z_r - h_e)/z)^2] + \exp[-\tfrac{1}{2}((z_r + h_e)/z)^2]$$

$$+ \sum_{N=1}^{k} [\exp[-\tfrac{1}{2}((z_r - h_e - 2Nz_i)/z)^2]$$

$$+ \exp[-\tfrac{1}{2}((z_r + h_e - 2Nz_i)/z)^2]$$

$$+ \exp[-\tfrac{1}{2}((z_r - h_e + 2Nz_i)/z)^2]$$

$$+ \exp[-\tfrac{1}{2}((z_r + h_e + 2Nz_i)/z)^2]\ ]\ \}$$

Where:

X = concentration
Q = emission rate
u_s = wind speed at stack height
y = lateral dispersion parameter
z = vertical dispersion parameter
z_r = receptor height
h_e = height of plume centerline above ground
z_i = mixing height

k = summation level for multiple reflections of plume off of the ground and elevated inversion, usually ?4.

SCREEN3 uses all stabilities and wind speeds in an iterative process to determine a range of ambient pollution levels downwind of an air emission point.

We have largely adopted a regulatory agency methodology (ref: North Carolina DENR Air Quality Analysis Branch) in developing the protocol used for our assessment.

SCREEN3 inputs are specific for each stack and site location. Most are simple parameters based on physical measurements: source type, stack height and inside diameter, etc. Also, the model asks the user to enter a value for the emission rate in grams per second. For this report, we used the value of 0.126 g/s which corresponds to 1 pound per hour. With this value entered, the SCREEN3 calculates a *generic concentration factor* for the main stack which facilitates the use of the pounds per hour data for each air pollutant. This calculation is explained further below.

There are user options which allow SCREEN3 to adjust to local conditions. Model options selected for this investigation are:

Stack exit velocity: For vertical stacks, the exit velocity is entered. For horizontal stacks or those with rain caps or other deflectors, the formula is $v_i = v_r \sin(\alpha)$ where v_i is velocity to input into the model, v_r is the reported exit velocity, and α is the angle of the stack from horizontal. The minimum recommended input value is 0.01 meters/second.

Ambient air temperature: We used the regulatory default of 293 degrees-K, which is 68 degrees-F.

Receptor height: We used 2 meters to determine ambient pollution at nose level for children and adults.

Urban/rural option: Rural option selected throughout based on land use and population density within SRS and the surrounding areas.

Complex terrain analysis: This option is required when the local topography rises above the top of a 50 meter stack within 20 kilometers. The complex terrain option is also required for shorter stacks where the terrain exceeds stack height within 5 kilometers. Therefore, the complex terrain analysis was not selected.

Building downwash: Used to determine cavitation effects, elevated pollution concentrations caused by structures downwind of stack emissions. Not enough information was available regarding height, width and orientation of local structures to allow us to make determinations for building downwash. The most severe impacts of building downwash pollution would be on receptors within the plant site; i.e., employees and visitors. Subsequent studies will be necessary to measure these impacts.

Using the SCREEN3 model (Version 95250), we calculated a *generic concentration factor* (C_g) at the property line and/or in nearby population centers for each air pollution source. Next, we multiplied the generic concentration factor by the source's *pollutant emission rate* (E_p) to find the *modeled pollutant concentration* (C_m) for each toxic chemical.

The formula for the modeled pollutant concentration is:

$$C_g \times E_p = C_m$$

Where:

C_g = generic concentration factor (μg/m3/lb/hr)
E_p = pollutant emission rate (lb./hour)
C_m = modeled pollutant concentration (μg/m3)

The following conversion factors are used as needed:

Hourly concentration = C_m x 1.0
24-hour concentration = C_m x .4
Annual concentration = C_m x 0.08

The generic concentration factor was computed using stack parameters we obtained from Fibrominn's Application for Re-issuance of Part 70 Permit, *Results of Speciated Mercury Testing,* Eagle Mountain Scientific, Inc., Report No. 902487Hg, Table 2.1, September 3-4, 2008.

We obtained pollutant emission rates from the Application for PSD Permit to Construct and Federal Part 70 Permit to Operate for the Fibrominn Biomass Power Plant, Benson, MN, August 28, 2001

We obtained physical stack data from Fibrominn Biomass Power Plant Application for Re-issuance of Part 70 Permit, Eagle Mountain Scientific, Inc. Report No. 902487Hg, Table 2.1, September 3-4, 2008

<u>Conversion Factors</u>
Feet to Meters: 0.3048
Fahrenheit to Kelvin: 0.55555 (F-32) + 273
tons/year to pounds/hour: 1 ton/year x 2000 lbs/ton ÷8760 hours/year = 0.2283

ATTACHMENT 3

On the following pages are US EPA Worst-case Spreadsheet data for toxic air pollutants from a 50 Megawatt poultry manure incinerator. Each toxic pollutant is presented in a separate table: Ammonia, Arsenic, Beryllium, Cadmium, Chromium, Hydrogen Chloride, Manganese, Mercury, Nickel and Sulfuric Acid.

ARSENIC

Enter the peak emission rate of the contaminent of concern

Peak (30 min) Emission Rate =			**0.00091**	**g/s**	**0.032**	**tons/yr**
MW=			**74.92**			
Concern level			**0.000000075**	**ppm**	**2E-04**	**ug/m3**
Distance (M)	**Point**	**Area**	**Volume**	**Worst**		**Recommendation**
10	1.17E+01	1.56E+02	1.56E+01	**1.56E+02**		reduce emissions
100	6.71E-01	2.15E+01	7.01E+00	**2.15E+01**		reduce emissions
200	3.66E-01	8.51E+00	3.89E+00	**8.51E+00**		reduce emissions
300	2.52E-01	4.61E+00	2.50E+00	**4.61E+00**		reduce emissions
400	1.93E-01	2.92E+00	1.76E+00	**2.92E+00**		reduce emissions
500	1.57E-01	2.04E+00	1.32E+00	**2.04E+00**		reduce emissions
600	1.33E-01	1.51E+00	1.06E+00	**1.51E+00**		reduce emissions
700	1.13E-01	1.17E+00	8.58E-01	**1.17E+00**		reduce emissions
800	9.81E-02	9.49E-01	7.13E-01	**9.49E-01**		reduce emissions
900	9.85E-02	7.89E-01	6.11E-01	**7.89E-01**		reduce emissions
1000	9.87E-02	6.68E-01	5.28E-01	**6.68E-01**		reduce emissions
1100	9.73E-02	5.78E-01	4.62E-01	**5.78E-01**		reduce emissions
1200	9.74E-02	5.06E-01	4.08E-01	**5.06E-01**		reduce emissions
1300	9.72E-02	4.48E-01	3.64E-01	**4.48E-01**		reduce emissions
1400	9.64E-02	4.00E-01	3.28E-01	**4.00E-01**		reduce emissions
1500	9.51E-02	3.60E-01	2.97E-01	**3.60E-01**		reduce emissions
1600	9.35E-02	3.26E-01	2.70E-01	**3.26E-01**		reduce emissions
1700	9.15E-02	2.97E-01	2.48E-01	**2.97E-01**		reduce emissions
1800	8.95E-02	2.72E-01	2.28E-01	**2.72E-01**		reduce emissions
1900	8.73E-02	2.51E-01	2.10E-01	**2.51E-01**		reduce emissions
2000	8.51E-02	2.32E-01	1.98E-01	**2.32E-01**		reduce emissions
2100	8.26E-02	2.16E-01	1.85E-01	**2.16E-01**		reduce emissions
2200	8.02E-02	2.02E-01	1.73E-01	**2.02E-01**		reduce emissions
2300	7.79E-02	1.89E-01	1.63E-01	**1.89E-01**		reduce emissions
2400	7.56E-02	1.78E-01	1.53E-01	**1.78E-01**		reduce emissions
2500	7.34E-02	1.68E-01	1.45E-01	**1.68E-01**		reduce emissions
2600	7.13E-02	1.59E-01	1.37E-01	**1.59E-01**		reduce emissions
2700	6.93E-02	1.50E-01	1.30E-01	**1.50E-01**		reduce emissions
2800	6.73E-02	1.42E-01	1.24E-01	**1.42E-01**		reduce emissions
2900	6.54E-02	1.35E-01	1.18E-01	**1.35E-01**		reduce emissions
3000	6.36E-02	1.29E-01	1.13E-01	**1.29E-01**		reduce emissions
3500	5.56E-02	1.04E-01	9.17E-02	**1.04E-01**		reduce emissions
4000	4.91E-02	8.71E-02	7.67E-02	**8.71E-02**		reduce emissions
4500	4.38E-02	7.42E-02	6.55E-02	**7.42E-02**		reduce emissions

5000	3.94E-02	6.43E-02	5.69E-02	**6.43E-02**	reduce emissions
5500	3.57E-02	5.64E-02	5.01E-02	**5.64E-02**	reduce emissions
6000	3.26E-02	5.01E-02	4.45E-02	**5.01E-02**	reduce emissions
6500	2.99E-02	4.50E-02	4.00E-02	**4.50E-02**	reduce emissions
7000	2.75E-02	4.07E-02	3.62E-02	**4.07E-02**	reduce emissions
7500	2.56E-02	3.72E-02	3.31E-02	**3.72E-02**	reduce emissions
8000	2.38E-02	3.42E-02	3.05E-02	**3.42E-02**	reduce emissions
8500	2.23E-02	3.16E-02	2.82E-02	**3.16E-02**	reduce emissions
9000	2.09E-02	2.93E-02	2.62E-02	**2.93E-02**	reduce emissions
9500	1.97E-02	2.73E-02	2.44E-02	**2.73E-02**	reduce emissions
10000	1.86E-02	2.55E-02	2.28E-02	**2.55E-02**	reduce emissions

BERYLLIUM

Enter the peak emission rate of the contaminent of concern

Peak (30 min) Emission Rate =			**0.00039**	**g/s**	**0.014** **tons/yr**
MW=			**9.01**		
Concern level			**0.000011**	**ppm**	**0.004** **ug/m3**

Distance (M)	**Point**	**Area**	**Volume**	**Worst**	**Recommendation**
10	5.00E+00	6.70E+01	6.67E+00	**6.70E+01**	reduce emissions
100	2.87E-01	9.21E+00	3.00E+00	**9.21E+00**	reduce emissions
200	1.57E-01	3.65E+00	1.67E+00	**3.65E+00**	reduce emissions
300	1.08E-01	1.98E+00	1.07E+00	**1.98E+00**	reduce emissions
400	8.29E-02	1.25E+00	7.56E-01	**1.25E+00**	reduce emissions
500	6.74E-02	8.73E-01	5.64E-01	**8.73E-01**	reduce emissions
600	5.70E-02	6.47E-01	4.53E-01	**6.47E-01**	reduce emissions
700	4.82E-02	5.02E-01	3.68E-01	**5.02E-01**	reduce emissions
800	4.20E-02	4.07E-01	3.06E-01	**4.07E-01**	reduce emissions
900	4.22E-02	3.38E-01	2.62E-01	**3.38E-01**	reduce emissions
1000	4.23E-02	2.86E-01	2.26E-01	**2.86E-01**	reduce emissions
1100	4.17E-02	2.48E-01	1.98E-01	**2.48E-01**	reduce emissions
1200	4.17E-02	2.17E-01	1.75E-01	**2.17E-01**	reduce emissions
1300	4.17E-02	1.92E-01	1.56E-01	**1.92E-01**	reduce emissions
1400	4.13E-02	1.71E-01	1.40E-01	**1.71E-01**	reduce emissions
1500	4.08E-02	1.54E-01	1.27E-01	**1.54E-01**	reduce emissions
1600	4.01E-02	1.40E-01	1.16E-01	**1.40E-01**	reduce emissions
1700	3.92E-02	1.27E-01	1.06E-01	**1.27E-01**	reduce emissions
1800	3.83E-02	1.17E-01	9.76E-02	**1.17E-01**	reduce emissions
1900	3.74E-02	1.07E-01	9.02E-02	**1.07E-01**	reduce emissions
2000	3.65E-02	9.93E-02	8.47E-02	**9.93E-02**	reduce emissions
2100	3.54E-02	9.25E-02	7.92E-02	**9.25E-02**	reduce emissions
2200	3.44E-02	8.65E-02	7.42E-02	**8.65E-02**	reduce emissions
2300	3.34E-02	8.11E-02	6.98E-02	**8.11E-02**	reduce emissions
2400	3.24E-02	7.63E-02	6.57E-02	**7.63E-02**	reduce emissions
2500	3.15E-02	7.19E-02	6.21E-02	**7.19E-02**	reduce emissions
2600	3.06E-02	6.79E-02	5.87E-02	**6.79E-02**	reduce emissions
2700	2.97E-02	6.44E-02	5.57E-02	**6.44E-02**	reduce emissions
2800	2.89E-02	6.10E-02	5.30E-02	**6.10E-02**	reduce emissions
2900	2.80E-02	5.80E-02	5.04E-02	**5.80E-02**	reduce emissions

3000	2.73E-02	5.53E-02	4.83E-02	**5.53E-02**	reduce emissions
3500	2.38E-02	4.48E-02	3.93E-02	**4.48E-02**	reduce emissions
4000	2.10E-02	3.73E-02	3.29E-02	**3.73E-02**	reduce emissions
4500	1.88E-02	3.18E-02	2.81E-02	**3.18E-02**	reduce emissions
5000	1.69E-02	2.75E-02	2.44E-02	**2.75E-02**	reduce emissions
5500	1.53E-02	2.42E-02	2.15E-02	**2.42E-02**	reduce emissions
6000	1.40E-02	2.15E-02	1.91E-02	**2.15E-02**	reduce emissions
6500	1.28E-02	1.93E-02	1.71E-02	**1.93E-02**	reduce emissions
7000	1.18E-02	1.74E-02	1.55E-02	**1.74E-02**	reduce emissions
7500	1.10E-02	1.59E-02	1.42E-02	**1.59E-02**	reduce emissions
8000	1.02E-02	1.46E-02	1.31E-02	**1.46E-02**	reduce emissions
8500	9.54E-03	1.35E-02	1.21E-02	**1.35E-02**	reduce emissions
9000	8.95E-03	1.26E-02	1.12E-02	**1.26E-02**	reduce emissions
9500	8.43E-03	1.17E-02	1.05E-02	**1.17E-02**	reduce emissions
10000	7.96E-03	1.09E-02	9.78E-03	**1.09E-02**	reduce emissions

CADMIUM

Enter the peak emission rate of the contaminent of concern

Peak (30 min) Emission Rate =	**0.00023**	**g/s**	**0.008**	**tons/yr**
MW=	**112.41**			
Concern level	**0.0000012**	**ppm**	**0.006**	**ug/m3**

Distance (M)	**Point**	**Area**	**Volume**	**Worst**	**Recommendation**
10	2.89E+00	3.87E+01	3.85E+00	**3.87E+01**	reduce emissions
100	1.66E-01	5.31E+00	1.73E+00	**5.31E+00**	reduce emissions
200	9.05E-02	2.10E+00	9.61E-01	**2.10E+00**	reduce emissions
300	6.23E-02	1.14E+00	6.19E-01	**1.14E+00**	reduce emissions
400	4.78E-02	7.23E-01	4.36E-01	**7.23E-01**	reduce emissions
500	3.89E-02	5.04E-01	3.26E-01	**5.04E-01**	reduce emissions
600	3.29E-02	3.74E-01	2.61E-01	**3.74E-01**	reduce emissions
700	2.78E-02	2.89E-01	2.12E-01	**2.89E-01**	reduce emissions
800	2.43E-02	2.35E-01	1.76E-01	**2.35E-01**	reduce emissions
900	2.43E-02	1.95E-01	1.51E-01	**1.95E-01**	reduce emissions
1000	2.44E-02	1.65E-01	1.30E-01	**1.65E-01**	reduce emissions
1100	2.41E-02	1.43E-01	1.14E-01	**1.43E-01**	reduce emissions
1200	2.41E-02	1.25E-01	1.01E-01	**1.25E-01**	reduce emissions
1300	2.40E-02	1.11E-01	9.01E-02	**1.11E-01**	reduce emissions
1400	2.38E-02	9.88E-02	8.10E-02	**9.88E-02**	reduce emissions
1500	2.35E-02	8.89E-02	7.34E-02	**8.89E-02**	reduce emissions
1600	2.31E-02	8.06E-02	6.68E-02	**8.06E-02**	reduce emissions
1700	2.26E-02	7.34E-02	6.12E-02	**7.34E-02**	reduce emissions
1800	2.21E-02	6.73E-02	5.63E-02	**6.73E-02**	reduce emissions
1900	2.16E-02	6.19E-02	5.20E-02	**6.19E-02**	reduce emissions
2000	2.10E-02	5.73E-02	4.89E-02	**5.73E-02**	reduce emissions
2100	2.04E-02	5.34E-02	4.57E-02	**5.34E-02**	reduce emissions
2200	1.98E-02	4.99E-02	4.28E-02	**4.99E-02**	reduce emissions
2300	1.93E-02	4.68E-02	4.03E-02	**4.68E-02**	reduce emissions
2400	1.87E-02	4.40E-02	3.79E-02	**4.40E-02**	reduce emissions
2500	1.82E-02	4.15E-02	3.58E-02	**4.15E-02**	reduce emissions
2600	1.76E-02	3.92E-02	3.39E-02	**3.92E-02**	reduce emissions

2700	1.71E-02	3.71E-02	3.22E-02	**3.71E-02**	reduce emissions
2800	1.66E-02	3.52E-02	3.06E-02	**3.52E-02**	reduce emissions
2900	1.62E-02	3.35E-02	2.91E-02	**3.35E-02**	reduce emissions
3000	1.57E-02	3.19E-02	2.79E-02	**3.19E-02**	reduce emissions
3500	1.37E-02	2.58E-02	2.27E-02	**2.58E-02**	reduce emissions
4000	1.21E-02	2.15E-02	1.90E-02	**2.15E-02**	reduce emissions
4500	1.08E-02	1.83E-02	1.62E-02	**1.83E-02**	reduce emissions
5000	9.74E-03	1.59E-02	1.41E-02	**1.59E-02**	reduce emissions
5500	8.82E-03	1.40E-02	1.24E-02	**1.40E-02**	reduce emissions
6000	8.05E-03	1.24E-02	1.10E-02	**1.24E-02**	reduce emissions
6500	7.38E-03	1.11E-02	9.89E-03	**1.11E-02**	reduce emissions
7000	6.81E-03	1.01E-02	8.96E-03	**1.01E-02**	reduce emissions
7500	6.32E-03	9.19E-03	8.19E-03	**9.19E-03**	reduce emissions
8000	5.89E-03	8.44E-03	7.53E-03	**8.44E-03**	reduce emissions
8500	5.51E-03	7.80E-03	6.96E-03	**7.80E-03**	reduce emissions
9000	5.17E-03	7.24E-03	6.47E-03	**7.24E-03**	reduce emissions
9500	4.86E-03	6.75E-03	6.03E-03	**6.75E-03**	reduce emissions
10000	4.59E-03	6.31E-03	5.64E-03	**6.31E-03**	reduce emissions

CHROMIUM

Enter the peak emission rate of the contaminent of concern

Peak (30 min) Emission Rate =	**0.00151**	**g/s**	**0.052**	**tons/yr**
MW=	**51.99**			
Concern level	**0.000000039**	**ppm**	**8E-05**	**ug/m3**

Distance (M)	**Point**	**Area**	**Volume**	**Worst**	**Recommendation**
10	1.94E+01	2.59E+02	2.58E+01	**2.59E+02**	reduce emissions
100	1.11E+00	3.57E+01	1.16E+01	**3.57E+01**	reduce emissions
200	6.07E-01	1.41E+01	6.45E+00	**1.41E+01**	reduce emissions
300	4.18E-01	7.66E+00	4.16E+00	**7.66E+00**	reduce emissions
400	3.21E-01	4.85E+00	2.93E+00	**4.85E+00**	reduce emissions
500	2.61E-01	3.38E+00	2.18E+00	**3.38E+00**	reduce emissions
600	2.21E-01	2.51E+00	1.75E+00	**2.51E+00**	reduce emissions
700	1.87E-01	1.94E+00	1.42E+00	**1.94E+00**	reduce emissions
800	1.63E-01	1.57E+00	1.18E+00	**1.57E+00**	reduce emissions
900	1.63E-01	1.31E+00	1.01E+00	**1.31E+00**	reduce emissions
1000	1.64E-01	1.11E+00	8.76E-01	**1.11E+00**	reduce emissions
1100	1.61E-01	9.59E-01	7.66E-01	**9.59E-01**	reduce emissions
1200	1.62E-01	8.40E-01	6.77E-01	**8.40E-01**	reduce emissions
1300	1.61E-01	7.43E-01	6.04E-01	**7.43E-01**	reduce emissions
1400	1.60E-01	6.63E-01	5.44E-01	**6.63E-01**	reduce emissions
1500	1.58E-01	5.97E-01	4.92E-01	**5.97E-01**	reduce emissions
1600	1.55E-01	5.41E-01	4.48E-01	**5.41E-01**	reduce emissions
1700	1.52E-01	4.93E-01	4.11E-01	**4.93E-01**	reduce emissions
1800	1.48E-01	4.51E-01	3.78E-01	**4.51E-01**	reduce emissions
1900	1.45E-01	4.16E-01	3.49E-01	**4.16E-01**	reduce emissions
2000	1.41E-01	3.84E-01	3.28E-01	**3.84E-01**	reduce emissions
2100	1.37E-01	3.58E-01	3.07E-01	**3.58E-01**	reduce emissions
2200	1.33E-01	3.35E-01	2.87E-01	**3.35E-01**	reduce emissions

2300	1.29E-01	3.14E-01	2.70E-01	**3.14E-01**	reduce emissions
2400	1.25E-01	2.95E-01	2.54E-01	**2.95E-01**	reduce emissions
2500	1.22E-01	2.78E-01	2.40E-01	**2.78E-01**	reduce emissions
2600	1.18E-01	2.63E-01	2.27E-01	**2.63E-01**	reduce emissions
2700	1.15E-01	2.49E-01	2.16E-01	**2.49E-01**	reduce emissions
2800	1.12E-01	2.36E-01	2.05E-01	**2.36E-01**	reduce emissions
2900	1.09E-01	2.25E-01	1.95E-01	**2.25E-01**	reduce emissions
3000	1.06E-01	2.14E-01	1.87E-01	**2.14E-01**	reduce emissions
3500	9.22E-02	1.73E-01	1.52E-01	**1.73E-01**	reduce emissions
4000	8.14E-02	1.44E-01	1.27E-01	**1.44E-01**	reduce emissions
4500	7.26E-02	1.23E-01	1.09E-01	**1.23E-01**	reduce emissions
5000	6.54E-02	1.07E-01	9.44E-02	**1.07E-01**	reduce emissions
5500	5.92E-02	9.37E-02	8.31E-02	**9.37E-02**	reduce emissions
6000	5.40E-02	8.32E-02	7.39E-02	**8.32E-02**	reduce emissions
6500	4.96E-02	7.46E-02	6.64E-02	**7.46E-02**	reduce emissions
7000	4.57E-02	6.75E-02	6.01E-02	**6.75E-02**	reduce emissions
7500	4.24E-02	6.17E-02	5.50E-02	**6.17E-02**	reduce emissions
8000	3.95E-02	5.67E-02	5.06E-02	**5.67E-02**	reduce emissions
8500	3.69E-02	5.24E-02	4.67E-02	**5.24E-02**	reduce emissions
9000	3.47E-02	4.86E-02	4.34E-02	**4.86E-02**	reduce emissions
9500	3.26E-02	4.53E-02	4.05E-02	**4.53E-02**	reduce emissions
10000	3.08E-02	4.24E-02	3.79E-02	**4.24E-02**	reduce emissions

MANGANESE

Enter the peak emission rate of the contaminent of concern

Peak (30 min) Emission Rate =	**0.00814**	**g/s**	**0.283**	**tons/yr**
MW=	**54.94**			
Concern level	**0.0137**	**ppm**	**30.78**	**ug/m3**

Distance (M)	**Point**	**Area**	**Volume**	**Worst**	**Recommendation**
10	1.04E+02	1.40E+03	1.39E+02	**1.40E+03**	reduce emissions
100	6.00E+00	1.92E+02	6.27E+01	**1.92E+02**	reduce emissions
200	3.27E+00	7.61E+01	3.48E+01	**7.61E+01**	reduce emissions
300	2.25E+00	4.13E+01	2.24E+01	**4.13E+01**	reduce emissions
400	1.73E+00	2.62E+01	1.58E+01	**2.62E+01**	its OK
500	1.41E+00	1.82E+01	1.18E+01	**1.82E+01**	its OK
600	1.19E+00	1.35E+01	9.45E+00	**1.35E+01**	its OK
700	1.01E+00	1.05E+01	7.67E+00	**1.05E+01**	its OK
800	8.77E-01	8.49E+00	6.38E+00	**8.49E+00**	its OK
900	8.81E-01	7.06E+00	5.47E+00	**7.06E+00**	its OK
1000	8.83E-01	5.98E+00	4.72E+00	**5.98E+00**	its OK
1100	8.70E-01	5.17E+00	4.13E+00	**5.17E+00**	its OK
1200	8.71E-01	4.53E+00	3.65E+00	**4.53E+00**	its OK
1300	8.69E-01	4.00E+00	3.26E+00	**4.00E+00**	its OK
1400	8.62E-01	3.58E+00	2.93E+00	**3.58E+00**	its OK
1500	8.51E-01	3.22E+00	2.65E+00	**3.22E+00**	its OK
1600	8.36E-01	2.91E+00	2.42E+00	**2.91E+00**	its OK

1700	8.19E-01	2.66E+00	2.21E+00	**2.66E+00**	its OK
1800	8.00E-01	2.43E+00	2.04E+00	**2.43E+00**	its OK
1900	7.81E-01	2.24E+00	1.88E+00	**2.24E+00**	its OK
2000	7.61E-01	2.07E+00	1.77E+00	**2.07E+00**	its OK
2100	7.39E-01	1.93E+00	1.65E+00	**1.93E+00**	its OK
2200	7.18E-01	1.81E+00	1.55E+00	**1.81E+00**	its OK
2300	6.97E-01	1.69E+00	1.46E+00	**1.69E+00**	its OK
2400	6.76E-01	1.59E+00	1.37E+00	**1.59E+00**	its OK
2500	6.57E-01	1.50E+00	1.30E+00	**1.50E+00**	its OK
2600	6.38E-01	1.42E+00	1.23E+00	**1.42E+00**	its OK
2700	6.20E-01	1.34E+00	1.16E+00	**1.34E+00**	its OK
2800	6.02E-01	1.27E+00	1.11E+00	**1.27E+00**	its OK
2900	5.85E-01	1.21E+00	1.05E+00	**1.21E+00**	its OK
3000	5.69E-01	1.15E+00	1.01E+00	**1.15E+00**	its OK
3500	4.97E-01	9.34E-01	8.21E-01	**9.34E-01**	its OK
4000	4.39E-01	7.79E-01	6.86E-01	**7.79E-01**	its OK
4500	3.92E-01	6.63E-01	5.86E-01	**6.63E-01**	its OK
5000	3.52E-01	5.75E-01	5.09E-01	**5.75E-01**	its OK
5500	3.19E-01	5.05E-01	4.48E-01	**5.05E-01**	its OK
6000	2.91E-01	4.49E-01	3.98E-01	**4.49E-01**	its OK
6500	2.67E-01	4.02E-01	3.58E-01	**4.02E-01**	its OK
7000	2.46E-01	3.64E-01	3.24E-01	**3.64E-01**	its OK
7500	2.29E-01	3.32E-01	2.96E-01	**3.32E-01**	its OK
8000	2.13E-01	3.05E-01	2.73E-01	**3.05E-01**	its OK
8500	1.99E-01	2.82E-01	2.52E-01	**2.82E-01**	its OK
9000	1.87E-01	2.62E-01	2.34E-01	**2.62E-01**	its OK
9500	1.76E-01	2.44E-01	2.18E-01	**2.44E-01**	its OK
10000	1.66E-01	2.28E-01	2.04E-01	**2.28E-01**	its OK

MERCURY

Enter the peak emission rate of the contaminent of concern

Peak (30 min) Emission Rate =	**0.00081**	**g/s**	**0.028**	**tons/yr**
MW=	**200.59**			
Concern level	**0.000073**	**ppm**	**0.599**	**ug/m3**

Distance (M)	**Point**	**Area**	**Volume**	**Worst**	**Recommendation**
10	1.04E+01	1.39E+02	1.39E+01	**1.39E+02**	reduce emissions
100	5.97E-01	1.91E+01	6.24E+00	**1.91E+01**	reduce emissions
200	3.26E-01	7.57E+00	3.46E+00	**7.57E+00**	reduce emissions
300	2.24E-01	4.11E+00	2.23E+00	**4.11E+00**	reduce emissions
400	1.72E-01	2.60E+00	1.57E+00	**2.60E+00**	reduce emissions
500	1.40E-01	1.81E+00	1.17E+00	**1.81E+00**	reduce emissions
600	1.18E-01	1.34E+00	9.40E-01	**1.34E+00**	reduce emissions
700	1.00E-01	1.04E+00	7.63E-01	**1.04E+00**	reduce emissions
800	8.73E-02	8.45E-01	6.35E-01	**8.45E-01**	reduce emissions
900	8.76E-02	7.02E-01	5.44E-01	**7.02E-01**	reduce emissions
1000	8.79E-02	5.95E-01	4.70E-01	**5.95E-01**	its OK
1100	8.66E-02	5.14E-01	4.11E-01	**5.14E-01**	its OK
1200	8.67E-02	4.50E-01	3.63E-01	**4.50E-01**	its OK

1300	8.65E-02	3.99E-01	3.24E-01	**3.99E-01**	its OK
1400	8.58E-02	3.56E-01	2.92E-01	**3.56E-01**	its OK
1500	8.46E-02	3.20E-01	2.64E-01	**3.20E-01**	its OK
1600	8.32E-02	2.90E-01	2.41E-01	**2.90E-01**	its OK
1700	8.15E-02	2.64E-01	2.20E-01	**2.64E-01**	its OK
1800	7.96E-02	2.42E-01	2.03E-01	**2.42E-01**	its OK
1900	7.77E-02	2.23E-01	1.87E-01	**2.23E-01**	its OK
2000	7.57E-02	2.06E-01	1.76E-01	**2.06E-01**	its OK
2100	7.35E-02	1.92E-01	1.65E-01	**1.92E-01**	its OK
2200	7.14E-02	1.80E-01	1.54E-01	**1.80E-01**	its OK
2300	6.93E-02	1.68E-01	1.45E-01	**1.68E-01**	its OK
2400	6.73E-02	1.58E-01	1.36E-01	**1.58E-01**	its OK
2500	6.54E-02	1.49E-01	1.29E-01	**1.49E-01**	its OK
2600	6.35E-02	1.41E-01	1.22E-01	**1.41E-01**	its OK
2700	6.17E-02	1.34E-01	1.16E-01	**1.34E-01**	its OK
2800	5.99E-02	1.27E-01	1.10E-01	**1.27E-01**	its OK
2900	5.82E-02	1.21E-01	1.05E-01	**1.21E-01**	its OK
3000	5.66E-02	1.15E-01	1.00E-01	**1.15E-01**	its OK
3500	4.95E-02	9.30E-02	8.16E-02	**9.30E-02**	its OK
4000	4.37E-02	7.75E-02	6.83E-02	**7.75E-02**	its OK
4500	3.90E-02	6.60E-02	5.83E-02	**6.60E-02**	its OK
5000	3.51E-02	5.72E-02	5.06E-02	**5.72E-02**	its OK
5500	3.18E-02	5.02E-02	4.46E-02	**5.02E-02**	its OK
6000	2.90E-02	4.46E-02	3.96E-02	**4.46E-02**	its OK
6500	2.66E-02	4.00E-02	3.56E-02	**4.00E-02**	its OK
7000	2.45E-02	3.62E-02	3.22E-02	**3.62E-02**	its OK
7500	2.27E-02	3.31E-02	2.95E-02	**3.31E-02**	its OK
8000	2.12E-02	3.04E-02	2.71E-02	**3.04E-02**	its OK
8500	1.98E-02	2.81E-02	2.51E-02	**2.81E-02**	its OK
9000	1.86E-02	2.61E-02	2.33E-02	**2.61E-02**	its OK
9500	1.75E-02	2.43E-02	2.17E-02	**2.43E-02**	its OK
10000	1.65E-02	2.27E-02	2.03E-02	**2.27E-02**	its OK

NICKEL

Enter the peak emission rate of the contaminent of concern

Peak (30 min) Emission Rate =	**0.00549**	**g/s**	**0.191**	**tons/yr**
MW=	**58.69**			
Concern level	**0.0025**	**ppm**	**6.001**	**ug/m3**

Distance (M)	**Point**	**Area**	**Volume**	**Worst**	**Recommendation**
10	7.04E+01	9.43E+02	9.39E+01	**9.43E+02**	reduce emissions
100	4.05E+00	1.30E+02	4.23E+01	**1.30E+02**	reduce emissions
200	2.21E+00	5.13E+01	2.35E+01	**5.13E+01**	reduce emissions
300	1.52E+00	2.78E+01	1.51E+01	**2.78E+01**	reduce emissions
400	1.17E+00	1.76E+01	1.06E+01	**1.76E+01**	reduce emissions
500	9.49E-01	1.23E+01	7.94E+00	**1.23E+01**	reduce emissions
600	8.03E-01	9.11E+00	6.37E+00	**9.11E+00**	reduce emissions
700	6.79E-01	7.06E+00	5.17E+00	**7.06E+00**	reduce emissions
800	5.92E-01	5.73E+00	4.30E+00	**5.73E+00**	its OK

900	5.94E-01	4.76E+00	3.69E+00	**4.76E+00**	its OK
1000	5.96E-01	4.03E+00	3.18E+00	**4.03E+00**	its OK
1100	5.87E-01	3.49E+00	2.79E+00	**3.49E+00**	its OK
1200	5.87E-01	3.05E+00	2.46E+00	**3.05E+00**	its OK
1300	5.86E-01	2.70E+00	2.20E+00	**2.70E+00**	its OK
1400	5.81E-01	2.41E+00	1.98E+00	**2.41E+00**	its OK
1500	5.74E-01	2.17E+00	1.79E+00	**2.17E+00**	its OK
1600	5.64E-01	1.97E+00	1.63E+00	**1.97E+00**	its OK
1700	5.52E-01	1.79E+00	1.49E+00	**1.79E+00**	its OK
1800	5.40E-01	1.64E+00	1.37E+00	**1.64E+00**	its OK
1900	5.27E-01	1.51E+00	1.27E+00	**1.51E+00**	its OK
2000	5.13E-01	1.40E+00	1.19E+00	**1.40E+00**	its OK
2100	4.98E-01	1.30E+00	1.12E+00	**1.30E+00**	its OK
2200	4.84E-01	1.22E+00	1.04E+00	**1.22E+00**	its OK
2300	4.70E-01	1.14E+00	9.82E-01	**1.14E+00**	its OK
2400	4.56E-01	1.07E+00	9.25E-01	**1.07E+00**	its OK
2500	4.43E-01	1.01E+00	8.74E-01	**1.01E+00**	its OK
2600	4.30E-01	9.56E-01	8.27E-01	**9.56E-01**	its OK
2700	4.18E-01	9.06E-01	7.85E-01	**9.06E-01**	its OK
2800	4.06E-01	8.59E-01	7.46E-01	**8.59E-01**	its OK
2900	3.95E-01	8.17E-01	7.09E-01	**8.17E-01**	its OK
3000	3.84E-01	7.78E-01	6.80E-01	**7.78E-01**	its OK
3500	3.35E-01	6.30E-01	5.53E-01	**6.30E-01**	its OK
4000	2.96E-01	5.25E-01	4.63E-01	**5.25E-01**	its OK
4500	2.64E-01	4.47E-01	3.95E-01	**4.47E-01**	its OK
5000	2.38E-01	3.88E-01	3.43E-01	**3.88E-01**	its OK
5500	2.15E-01	3.41E-01	3.02E-01	**3.41E-01**	its OK
6000	1.96E-01	3.02E-01	2.69E-01	**3.02E-01**	its OK
6500	1.80E-01	2.71E-01	2.41E-01	**2.71E-01**	its OK
7000	1.66E-01	2.45E-01	2.19E-01	**2.45E-01**	its OK
7500	1.54E-01	2.24E-01	2.00E-01	**2.24E-01**	its OK
8000	1.44E-01	2.06E-01	1.84E-01	**2.06E-01**	its OK
8500	1.34E-01	1.90E-01	1.70E-01	**1.90E-01**	its OK
9000	1.26E-01	1.77E-01	1.58E-01	**1.77E-01**	its OK
9500	1.19E-01	1.65E-01	1.47E-01	**1.65E-01**	its OK
10000	1.12E-01	1.54E-01	1.38E-01	**1.54E-01**	its OK

HYDROGEN CHLORIDE

Enter the peak emission rate of the contaminent of concern

Peak (30 min) Emission Rate =	**3.39**	**g/s**	**117.7**	**tons/yr**
MW=	**36.47**			
Concern level	**0.469**	**ppm**	**699.6**	**ug/m3**

Distance (M)	**Point**	**Area**	**Volume**	**Worst**	**Recommendation**
10	4.35E+04	5.82E+05	5.80E+04	**5.82E+05**	reduce emissions
100	2.50E+03	8.00E+04	2.61E+04	**8.00E+04**	reduce emissions
200	1.36E+03	3.17E+04	1.45E+04	**3.17E+04**	reduce emissions

300	9.38E+02	1.72E+04	9.33E+03	**1.72E+04**	reduce emissions
400	7.21E+02	1.09E+04	6.57E+03	**1.09E+04**	reduce emissions
500	5.86E+02	7.59E+03	4.91E+03	**7.59E+03**	reduce emissions
600	4.96E+02	5.63E+03	3.94E+03	**5.63E+03**	reduce emissions
700	4.19E+02	4.36E+03	3.19E+03	**4.36E+03**	reduce emissions
800	3.65E+02	3.54E+03	2.66E+03	**3.54E+03**	reduce emissions
900	3.67E+02	2.94E+03	2.28E+03	**2.94E+03**	reduce emissions
1000	3.68E+02	2.49E+03	1.97E+03	**2.49E+03**	reduce emissions
1100	3.62E+02	2.15E+03	1.72E+03	**2.15E+03**	reduce emissions
1200	3.63E+02	1.88E+03	1.52E+03	**1.88E+03**	reduce emissions
1300	3.62E+02	1.67E+03	1.36E+03	**1.67E+03**	reduce emissions
1400	3.59E+02	1.49E+03	1.22E+03	**1.49E+03**	reduce emissions
1500	3.54E+02	1.34E+03	1.11E+03	**1.34E+03**	reduce emissions
1600	3.48E+02	1.21E+03	1.01E+03	**1.21E+03**	reduce emissions
1700	3.41E+02	1.11E+03	9.22E+02	**1.11E+03**	reduce emissions
1800	3.33E+02	1.01E+03	8.49E+02	**1.01E+03**	reduce emissions
1900	3.25E+02	9.33E+02	7.84E+02	**9.33E+02**	reduce emissions
2000	3.17E+02	8.63E+02	7.37E+02	**8.63E+02**	reduce emissions
2100	3.08E+02	8.04E+02	6.89E+02	**8.04E+02**	reduce emissions
2200	2.99E+02	7.52E+02	6.45E+02	**7.52E+02**	reduce emissions
2300	2.90E+02	7.05E+02	6.06E+02	**7.05E+02**	reduce emissions
2400	2.82E+02	6.63E+02	5.71E+02	**6.63E+02**	its OK
2500	2.74E+02	6.25E+02	5.40E+02	**6.25E+02**	its OK
2600	2.66E+02	5.91E+02	5.11E+02	**5.91E+02**	its OK
2700	2.58E+02	5.59E+02	4.84E+02	**5.59E+02**	its OK
2800	2.51E+02	5.31E+02	4.60E+02	**5.31E+02**	its OK
2900	2.44E+02	5.04E+02	4.38E+02	**5.04E+02**	its OK
3000	2.37E+02	4.80E+02	4.20E+02	**4.80E+02**	its OK
3500	2.07E+02	3.89E+02	3.42E+02	**3.89E+02**	its OK
4000	1.83E+02	3.24E+02	2.86E+02	**3.24E+02**	its OK
4500	1.63E+02	2.76E+02	2.44E+02	**2.76E+02**	its OK
5000	1.47E+02	2.39E+02	2.12E+02	**2.39E+02**	its OK
5500	1.33E+02	2.10E+02	1.86E+02	**2.10E+02**	its OK
6000	1.21E+02	1.87E+02	1.66E+02	**1.87E+02**	its OK
6500	1.11E+02	1.68E+02	1.49E+02	**1.68E+02**	its OK
7000	1.03E+02	1.52E+02	1.35E+02	**1.52E+02**	its OK
7500	9.52E+01	1.38E+02	1.23E+02	**1.38E+02**	its OK
8000	8.87E+01	1.27E+02	1.13E+02	**1.27E+02**	its OK
8500	8.30E+01	1.18E+02	1.05E+02	**1.18E+02**	its OK
9000	7.78E+01	1.09E+02	9.74E+01	**1.09E+02**	its OK
9500	7.33E+01	1.02E+02	9.09E+01	**1.02E+02**	its OK
10000	6.92E+01	9.51E+01	8.50E+01	**9.51E+01**	its OK

SULFURIC ACID

Enter the peak emission rate of the contaminent of concern

Peak (30 min) Emission Rate =	**5.59**	**g/s**	**194.1**	**tons/yr**
MW=	**98.08**			
Concern level	**0.00299**	**ppm**	**11.99**	**ug/m3**

Distance (M)	Point	Area	Volume	Worst	Recommendation
10	7.17E+04	9.60E+05	9.56E+04	**9.60E+05**	reduce emissions
100	4.12E+03	1.32E+05	4.30E+04	**1.32E+05**	reduce emissions
200	2.25E+03	5.22E+04	2.39E+04	**5.22E+04**	reduce emissions
300	1.55E+03	2.83E+04	1.54E+04	**2.83E+04**	reduce emissions
400	1.19E+03	1.80E+04	1.08E+04	**1.80E+04**	reduce emissions
500	9.66E+02	1.25E+04	8.09E+03	**1.25E+04**	reduce emissions
600	8.17E+02	9.28E+03	6.49E+03	**9.28E+03**	reduce emissions
700	6.91E+02	7.19E+03	5.27E+03	**7.19E+03**	reduce emissions
800	6.03E+02	5.83E+03	4.38E+03	**5.83E+03**	reduce emissions
900	6.05E+02	4.85E+03	3.75E+03	**4.85E+03**	reduce emissions
1000	6.07E+02	4.11E+03	3.24E+03	**4.11E+03**	reduce emissions
1100	5.98E+02	3.55E+03	2.84E+03	**3.55E+03**	reduce emissions
1200	5.98E+02	3.11E+03	2.51E+03	**3.11E+03**	reduce emissions
1300	5.97E+02	2.75E+03	2.24E+03	**2.75E+03**	reduce emissions
1400	5.92E+02	2.46E+03	2.01E+03	**2.46E+03**	reduce emissions
1500	5.84E+02	2.21E+03	1.82E+03	**2.21E+03**	reduce emissions
1600	5.74E+02	2.00E+03	1.66E+03	**2.00E+03**	reduce emissions
1700	5.62E+02	1.82E+03	1.52E+03	**1.82E+03**	reduce emissions
1800	5.50E+02	1.67E+03	1.40E+03	**1.67E+03**	reduce emissions
1900	5.36E+02	1.54E+03	1.29E+03	**1.54E+03**	reduce emissions
2000	5.23E+02	1.42E+03	1.21E+03	**1.42E+03**	reduce emissions
2100	5.07E+02	1.33E+03	1.14E+03	**1.33E+03**	reduce emissions
2200	4.93E+02	1.24E+03	1.06E+03	**1.24E+03**	reduce emissions
2300	4.78E+02	1.16E+03	1.00E+03	**1.16E+03**	reduce emissions
2400	4.65E+02	1.09E+03	9.42E+02	**1.09E+03**	reduce emissions
2500	4.51E+02	1.03E+03	8.90E+02	**1.03E+03**	reduce emissions
2600	4.38E+02	9.74E+02	8.42E+02	**9.74E+02**	reduce emissions
2700	4.26E+02	9.22E+02	7.99E+02	**9.22E+02**	reduce emissions
2800	4.14E+02	8.75E+02	7.59E+02	**8.75E+02**	reduce emissions
2900	4.02E+02	8.32E+02	7.22E+02	**8.32E+02**	reduce emissions
3000	3.91E+02	7.92E+02	6.93E+02	**7.92E+02**	reduce emissions
3500	3.41E+02	6.42E+02	5.63E+02	**6.42E+02**	reduce emissions
4000	3.02E+02	5.35E+02	4.71E+02	**5.35E+02**	reduce emissions
4500	2.69E+02	4.56E+02	4.03E+02	**4.56E+02**	reduce emissions
5000	2.42E+02	3.95E+02	3.49E+02	**3.95E+02**	reduce emissions
5500	2.19E+02	3.47E+02	3.08E+02	**3.47E+02**	reduce emissions
6000	2.00E+02	3.08E+02	2.74E+02	**3.08E+02**	reduce emissions
6500	1.83E+02	2.76E+02	2.46E+02	**2.76E+02**	reduce emissions
7000	1.69E+02	2.50E+02	2.23E+02	**2.50E+02**	reduce emissions
7500	1.57E+02	2.28E+02	2.04E+02	**2.28E+02**	reduce emissions
8000	1.46E+02	2.10E+02	1.87E+02	**2.10E+02**	reduce emissions
8500	1.37E+02	1.94E+02	1.73E+02	**1.94E+02**	reduce emissions
9000	1.28E+02	1.80E+02	1.61E+02	**1.80E+02**	reduce emissions
9500	1.21E+02	1.68E+02	1.50E+02	**1.68E+02**	reduce emissions
10000	1.14E+02	1.57E+02	1.40E+02	**1.57E+02**	reduce emissions

AMMONIA

Enter the peak emission rate of the contaminent of concern

Peak (30 min) Emission Rate =	**1.6**	**g/s**	**55.57**	**tons/yr**	
MW=	**17.02**				
Concern level	**3.88**	**ppm**	**2701**	**ug/m3**	

Distance (M)	Point	Area	Volume	Worst	Recommendation
10	2.05E+04	2.75E+05	2.74E+04	**2.75E+05**	reduce emissions
100	1.18E+03	3.78E+04	1.23E+04	**3.78E+04**	reduce emissions
200	6.43E+02	1.50E+04	6.84E+03	**1.50E+04**	reduce emissions
300	4.43E+02	8.11E+03	4.40E+03	**8.11E+03**	reduce emissions
400	3.40E+02	5.14E+03	3.10E+03	**5.14E+03**	reduce emissions
500	2.76E+02	3.58E+03	2.32E+03	**3.58E+03**	reduce emissions
600	2.34E+02	2.66E+03	1.86E+03	**2.66E+03**	its OK
700	1.98E+02	2.06E+03	1.51E+03	**2.06E+03**	its OK
800	1.72E+02	1.67E+03	1.25E+03	**1.67E+03**	its OK
900	1.73E+02	1.39E+03	1.07E+03	**1.39E+03**	its OK
1000	1.74E+02	1.18E+03	9.28E+02	**1.18E+03**	its OK
1100	1.71E+02	1.02E+03	8.12E+02	**1.02E+03**	its OK
1200	1.71E+02	8.90E+02	7.18E+02	**8.90E+02**	its OK
1300	1.71E+02	7.87E+02	6.40E+02	**7.87E+02**	its OK
1400	1.69E+02	7.03E+02	5.76E+02	**7.03E+02**	its OK
1500	1.67E+02	6.32E+02	5.22E+02	**6.32E+02**	its OK
1600	1.64E+02	5.73E+02	4.75E+02	**5.73E+02**	its OK
1700	1.61E+02	5.22E+02	4.35E+02	**5.22E+02**	its OK
1800	1.57E+02	4.78E+02	4.00E+02	**4.78E+02**	its OK
1900	1.54E+02	4.40E+02	3.70E+02	**4.40E+02**	its OK
2000	1.50E+02	4.07E+02	3.48E+02	**4.07E+02**	its OK
2100	1.45E+02	3.80E+02	3.25E+02	**3.80E+02**	its OK
2200	1.41E+02	3.55E+02	3.04E+02	**3.55E+02**	its OK
2300	1.37E+02	3.33E+02	2.86E+02	**3.33E+02**	its OK
2400	1.33E+02	3.13E+02	2.70E+02	**3.13E+02**	its OK
2500	1.29E+02	2.95E+02	2.55E+02	**2.95E+02**	its OK
2600	1.25E+02	2.79E+02	2.41E+02	**2.79E+02**	its OK
2700	1.22E+02	2.64E+02	2.29E+02	**2.64E+02**	its OK
2800	1.18E+02	2.50E+02	2.17E+02	**2.50E+02**	its OK
2900	1.15E+02	2.38E+02	2.07E+02	**2.38E+02**	its OK
3000	1.12E+02	2.27E+02	1.98E+02	**2.27E+02**	its OK
3500	9.77E+01	1.84E+02	1.61E+02	**1.84E+02**	its OK
4000	8.63E+01	1.53E+02	1.35E+02	**1.53E+02**	its OK
4500	7.70E+01	1.30E+02	1.15E+02	**1.30E+02**	its OK
5000	6.92E+01	1.13E+02	1.00E+02	**1.13E+02**	its OK
5500	6.28E+01	9.92E+01	8.80E+01	**9.92E+01**	its OK
6000	5.72E+01	8.82E+01	7.83E+01	**8.82E+01**	its OK
6500	5.25E+01	7.91E+01	7.03E+01	**7.91E+01**	its OK
7000	4.84E+01	7.15E+01	6.37E+01	**7.15E+01**	its OK
7500	4.49E+01	6.53E+01	5.83E+01	**6.53E+01**	its OK
8000	4.19E+01	6.00E+01	5.36E+01	**6.00E+01**	its OK
8500	3.92E+01	5.55E+01	4.95E+01	**5.55E+01**	its OK
9000	3.67E+01	5.15E+01	4.60E+01	**5.15E+01**	its OK
9500	3.46E+01	4.80E+01	4.29E+01	**4.80E+01**	its OK

10000	3.26E+01	4.49E+01	4.01E+01	**4.49E+01**	its OK

HYDROGEN CHLORIDE(2)
Enter the peak emission rate of the contaminent of concern

Peak (30 min) Emission Rate =	**1.23**	**g/s**	**42.72**	**tons/yr**
MW=	**36.47**			
Concern level	**0.469**	**ppm**	**699.6**	**ug/m3**

Distance (M)	**Point**	**Area**	**Volume**	**Worst**	**Recommendation**
10	1.58E+04	2.11E+05	2.10E+04	**2.11E+05**	reduce emissions
100	9.07E+02	2.90E+04	9.47E+03	**2.90E+04**	reduce emissions
200	4.95E+02	1.15E+04	5.25E+03	**1.15E+04**	reduce emissions
300	3.40E+02	6.24E+03	3.38E+03	**6.24E+03**	reduce emissions
400	2.61E+02	3.95E+03	2.38E+03	**3.95E+03**	reduce emissions
500	2.13E+02	2.75E+03	1.78E+03	**2.75E+03**	reduce emissions
600	1.80E+02	2.04E+03	1.43E+03	**2.04E+03**	reduce emissions
700	1.52E+02	1.58E+03	1.16E+03	**1.58E+03**	reduce emissions
800	1.33E+02	1.28E+03	9.64E+02	**1.28E+03**	reduce emissions
900	1.33E+02	1.07E+03	8.26E+02	**1.07E+03**	reduce emissions
1000	1.33E+02	9.03E+02	7.13E+02	**9.03E+02**	reduce emissions
1100	1.31E+02	7.81E+02	6.24E+02	**7.81E+02**	reduce emissions
1200	1.32E+02	6.84E+02	5.52E+02	**6.84E+02**	its OK
1300	1.31E+02	6.05E+02	4.92E+02	**6.05E+02**	its OK
1400	1.30E+02	5.40E+02	4.43E+02	**5.40E+02**	its OK
1500	1.29E+02	4.86E+02	4.01E+02	**4.86E+02**	its OK
1600	1.26E+02	4.40E+02	3.65E+02	**4.40E+02**	its OK
1700	1.24E+02	4.01E+02	3.35E+02	**4.01E+02**	its OK
1800	1.21E+02	3.68E+02	3.08E+02	**3.68E+02**	its OK
1900	1.18E+02	3.39E+02	2.84E+02	**3.39E+02**	its OK
2000	1.15E+02	3.13E+02	2.67E+02	**3.13E+02**	its OK
2100	1.12E+02	2.92E+02	2.50E+02	**2.92E+02**	its OK
2200	1.08E+02	2.73E+02	2.34E+02	**2.73E+02**	its OK
2300	1.05E+02	2.56E+02	2.20E+02	**2.56E+02**	its OK
2400	1.02E+02	2.41E+02	2.07E+02	**2.41E+02**	its OK
2500	9.93E+01	2.27E+02	1.96E+02	**2.27E+02**	its OK
2600	9.64E+01	2.14E+02	1.85E+02	**2.14E+02**	its OK
2700	9.37E+01	2.03E+02	1.76E+02	**2.03E+02**	its OK
2800	9.10E+01	1.92E+02	1.67E+02	**1.92E+02**	its OK
2900	8.84E+01	1.83E+02	1.59E+02	**1.83E+02**	its OK
3000	8.60E+01	1.74E+02	1.52E+02	**1.74E+02**	its OK
3500	7.51E+01	1.41E+02	1.24E+02	**1.41E+02**	its OK
4000	6.63E+01	1.18E+02	1.04E+02	**1.18E+02**	its OK
4500	5.92E+01	1.00E+02	8.86E+01	**1.00E+02**	its OK
5000	5.32E+01	8.69E+01	7.69E+01	**8.69E+01**	its OK
5500	4.82E+01	7.63E+01	6.77E+01	**7.63E+01**	its OK
6000	4.40E+01	6.78E+01	6.02E+01	**6.78E+01**	its OK
6500	4.04E+01	6.08E+01	5.41E+01	**6.08E+01**	its OK
7000	3.72E+01	5.50E+01	4.90E+01	**5.50E+01**	its OK
7500	3.45E+01	5.02E+01	4.48E+01	**5.02E+01**	its OK
8000	3.22E+01	4.62E+01	4.12E+01	**4.62E+01**	its OK

8500	3.01E+01	4.27E+01	3.81E+01	**4.27E+01**	its OK
9000	2.82E+01	3.96E+01	3.54E+01	**3.96E+01**	its OK
9500	2.66E+01	3.69E+01	3.30E+01	**3.69E+01**	its OK
10000	2.51E+01	3.45E+01	3.08E+01	**3.45E+01**	its OK

Attachment 4

PUBLIC HEALTH IMPACT DATA

Ammonia (NH3) caustic and hazardous

Arsenic (As) The IARC lists element as Group 1, carcinogenic to humans

European Union directive 67/548/EEC, The International Agency for Research on Cancer (IARC)

Nickel (Ni) Nickel fume and dust is believed to be carcinogenic

KS Kasprzak, FW Sunderman Jr, K Salnikow. Nickel carcinogenesis. Mutation Research. 2003 Dec 10;533(1-2):67-97. PubMed

JK Dunnick, MR Elwell, AE Radovsky, JM Benson, FF Hahn, KJ Nikula, EB Barr, CH Hobbs. Comparative Carcinogenic Effects of Nickel Subsulfide, Nickel Oxide, or Nickel Sulfate Hexahydrate Chronic Exposures in the Lung. Cancer Research. 1995 Nov 15;55(22):5251-6. PubMed

Cadmium (Cd) Cadmium and several cadmium-containing compounds are known carcinogens and can induce many types of cancer.

"11th Report on Carcinogens" National Toxicology Program. http://ntp.niehs.nih.gov/index.cfm?objectid=32BA9724-F1F6-975E-7FCE50709CB4C932.

Chromium (Cr) when ingested, damages the kidneys, the liver and blood cells and is carcinogenic.

Dayan, A. D.; Paine, A. J. (2001). "Mechanisms of chromium toxicity, carcinogenicity and allergenicity: Review of the literature from 1985 to 2000". Human & Experimental Toxicology 20 (9): 439–451.

Newman, D. (1890). "A case of adeno-carcinoma of the left inferior turbinated body, and perforation of the nasal septum, in the person of a worker in chrome pigments". Glasgow Med J 33: 469–470.

Langard, Sverre (1990). "One Hundred Years of Chromium and Cancer: A Review of Epidemiological Evidence and Selected Case Reports". American Journal of Industrial Medicine 17: 189–215..

Manganese (Mn) poisoning has been linked to impaired motor skills and cognitive disorders

[Risk Assessment Information System Toxicity Summary for MANGANESE". Oak Ridge National Laboratory. http://rais.ornl.gov/tox/profiles/mn.shtml.]

Mercury (Hg) Mercury and most of its compounds are extremely toxic. effects include damage to the brain, kidney, and lungs

Clifton JC 2nd (2007). "Mercury exposure and public health". *Pediatr Clin North Am* 54 (2): 237–69, viii.

Hydrogen chloride (HCl) forms corrosive hydrochloric acid on contact with water found in body tissue. Inhalation of the fumes can cause coughing, choking, inflammation of the nose, throat, and upper respiratory tract, and in severe cases, pulmonary edema, circulatory system failure, and death

Public health and reference data from Wikipedia