

**Health Risk Assessment Technical Support Document
for Air Management Regulation VI Amendment**

By

**Air Management Services
Department of Public Health
City of Philadelphia
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I. List of Toxic Air Contaminants (Hazardous Air Pollutants)

The 1981 Air Management Regulation (AMR) VI lists 99 Toxic Air Contaminants (or Hazardous Air Pollutants (HAPs)). Over time, more air pollutants were found to cause cancer and other serious health effects. Under the 1990 federal Clean Air Act (CAA) Amendments, the original list of Hazardous Air Pollutants included 189 pollutants. Since then EPA has modified the list through rulemaking to include 188 HAPs ^[1].

This AMR VI amendment aims to regulate an updated list of Toxic Air Contaminants originally in the Appendix to the 1981 AMR VI. The updated list of Toxic Air Contaminants (HAPs) is in the Appendix to the amended AMR VI. This list incorporates nearly all one hundred eighty eight (188) pollutants that are classified as hazardous air pollutants (HAPs) by U.S. EPA pursuant to Section 112 of the Clean Air Act, and includes additional air pollutants that have been determined to have adverse health effects by Air Management Service (AMS), taking into consideration the hazardous air pollutants listed by the New Jersey Department of Environmental Protection. It contains 217 chemical compounds and compound groups in total. The *Technical Guidelines for Air Management Regulation VI* document specifies the Reporting Threshold for each of chemical compounds (compound groups).

II. Establishing Hazardous Air Pollutants Reporting Thresholds

The objective of this section is to establish HAP Reporting Thresholds which can be used, as part of the AMS permitting process, in a health risk assessment to determine if there is the potential of HAP emissions to cause a significant health risk. A Reporting Threshold is an air pollutant emission rate (tons per year, or pounds per year) where The Philadelphia Department of Public Health (Department) has determined a health risk analysis is necessary. The methodology described below is used to determine the reporting thresholds. It is also used to establish the Risk Screening Workbook that will be used as a preliminary risk screening tool (also see Section III of *Technical Guidelines for Air Management Regulation VI*) in the permitting process. The methodology consists of the following three parts: Part 1: Modeling methodology; Part 2: Processing the modeling results; and Part 3: Identifying proposed threshold values.

2.1 Modeling Methodology

Instead of setting a reporting threshold for each HAP in an arbitrary way, air quality modeling was used to estimate highly conservative or worst-case scenarios of allowable emission rates of a HAP at which the health risks caused by the pollutant concentrations can be kept at a level that is considered negligible. These highly conservative or worst-case scenario allowable emission rates provide the basis to establish the reporting threshold.

2.1.1 Dispersion Model

A recent version of the American Meteorological Society/United States Environmental Protection Agency Regulatory Model (AERMOD, Version 18081) was used for this evaluation. AERMOD is

the US EPA preferred model for regulatory modeling applications. AERMOD is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts, including treatment of both surface and elevated sources, and both simple and complex terrains.

2.1.2 Land Use

To consider different land use types (dispersion environments) in Philadelphia, AERMOD was run in both the rural and urban modes. In the urban mode, a population parameter of 1,570,000 was used. This is approximately the population of the City of Philadelphia in 2017.

2.1.3 Meteorological Data

Meteorological data sets include ground level weather observation data and upper air profile data. Data collected in the years 2010-2014 were used. The ground level data were the Philadelphia International Airport data sets; the concurrent upper air data were from the Sterling, Virginia station according to EPA air modeling protocols. Figure 1 shows the five-year wind rose based on ground level data from the Philadelphia International Airport weather station.



Figure 1: Wind Rose based on Philadelphia International Airport data

2.1.4 Stack Parameters and Emission Rates

Hypothetical emission points and structures were entered into the model to represent a range of pollutant release and aerodynamic downwash scenarios for stacks. The stack parameters and emission rates used to generate the normalized air impact values (micrograms per cubic meter ($\mu\text{g}/\text{m}^3$)/pound per hour of HAP emitted for short term impacts, $\mu\text{g}/\text{m}^3$ / ton per year of HAP emitted for long term impacts) are listed in Table 1. The stack gas exit velocity and exit temperature values were selected so that plume rise would be minimal to provide highly conservative estimates. Emissions were assumed to occur 24 hours per day, 365 days per year. Each modeled stack is located in the middle of a group

of hypothetical buildings that are modeled for building downwash of the plume.

Table 1. Stack Parameters and Emission Rates

Parameter	Value
Normalized Annual Emission Rate	1 ton per year (normalized)
Normalized 1-Hour Emission Rate	1 pound per hour (lb/hour) (normalized)
Modeled Stack Heights (ft)	15, 20, 25, 30, 40, 50, 75, 100, 150, 200, 250
Modeled Stack Diameter	1 foot
Exit Velocity	0.33 feet per second
Exit temperature	80 degrees Fahrenheit (°F)

2.1.5 Building Downwash

The building dimensions were selected so that the plume was subjected to aerodynamic downwash in all wind directions. The building dimensions used, including assumed horizontal dimensions, are listed in Table 2. To consider conservative plume downwash scenarios, all stacks were assumed below the Good Engineering Practice (GEP) stack height of 2.5 times the building height. For stack heights of 15 ft and 20 ft, the stack was assumed to be a factor of 1.25 times the building height. For all other stack heights (25 ft through 250 ft), the stack was assumed to be a factor of 1.5 times the building height. For stack heights between 15 and 50 ft, the building’s horizontal dimensions were assumed constant at 50 ft. As stack heights increase above 50 ft, the building’s horizontal dimensions also increase. The assumed building’s horizontal dimensions are also shown in Table 2.

The US EPA’s Building Profile Input Program (BPIP-PRIME) was used to generate building downwash parameters for input into AERMOD.

Table 2. Stack Heights and Assumed Building Dimensions

Stack Height (ft)	Building Height (ft)	Building Width and Length (ft)
15	12	50 x 50
20	16	50 x 50
25	16.7	50 x 50
30	20	50 x 50
40	26.7	50 x 50
50	33.4	50 x 50
75	50	75 x 75
100	66.7	100 x 100
150	100	150 x 150
200	133.4	200 x 200
250	166.7	200 x 200

2.1.6 Receptor Grid

Modeling was performed assuming flat terrain within the modeled distance range. A polar receptor grid with 864 receptors was used that was centered on the stack (midpoint of the buildings) with 36 radials spaced every 10 degrees. The spacing of receptors along the radials were as follows to provide 24 distances: 20 ft, 30 ft, 40 ft, 50 ft, 60 ft, 70 ft, 80 ft, 90 ft, 100 ft, 150 ft, 200 ft, 250 ft, 300 ft, 400 ft, 500 ft, 600 ft, 700 ft, 800 ft, 900 ft, 1000 ft, 1500 ft, 2000 ft, 2500 ft, 3000 ft.

2.1.7 Model Input and Output

The AERMOD model was run with EPA's regulatory default parameters and the parameters discussed above. AERMOD was run to calculate hourly, daily (24-hour), and annual concentrations at each receptor location.

2.2 Processing Modeling Results

The above modeling methodology resulted in the following number of scenarios (impacts) being modeled:

2 dispersion environments x 5 sets of MET data x 2 normalized emission rates x 3 averaging times x 11 stack heights x 864 receptors = **570,240** impacts

In order to process such a large amount of data results, the AERMOD output files were reformatted and merged using a DOS batch processing script, then imported into Microsoft Excel. Statistical and pivot table functions in Excel were used to process the data. For each averaging time and each combination of stack height and receptor distance, the maximum normalized concentration was identified. For stack heights and distances not explicitly modeled (e.g. stack height 21 feet), linear interpolation across stack heights for a specified distance was performed to generate estimated concentration values. Similarly, concentrations at distances not explicitly modeled (e.g. 110 feet) were also estimated using linear interpolation.

Using this process, tables of worst-case hourly and annual impacts by stack height and distance were created for stacks from 15 ft to 250 ft and distances from 20 ft to 3,000 ft, including interpolated values. This resulted in 2,550 values in one table (Figure 2, normalized annual impacts). Each value represents the maximum concentration for a particular stack height and distance combination. However, for the purpose of setting HAP reporting threshold values, it is expected that the overall worst-case impacts will occur from shorter stacks at distances closer to the stack. Review of the AMS permitting and emission inventory data showed that at least 57% of approximately 1100 stacks (or release points) permitted in Philadelphia (not including small sources that are not reported in the emission inventories) are no more than 40 feet high. Of these stacks, at least 43% are located 150 feet or less from the closest facility property line. Based on this analysis, only hourly and annual impacts

for stacks no more than 40 ft and within 150 ft from the property line were considered. Again, this was meant to use more conservative scenarios in establishing reporting thresholds. In Figure 2, the area bounded by the blue box represents the subset of values used to establish the HAP reporting thresholds.

Distance	Stack Height (ft)										Stack Height (ft)										Stack Height (ft)										Stack Height (ft)																				
	15	17	19	21	23	24	25	26	27	28	30	32	34	36	38	40	42	44	46	48	50	55	60	65	70	75	80	85	90	95	100	105	110	120	130	140	150	160	170	180	190	200	210	220	230	240	250				
0	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
20	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
40	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
60	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
80	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
100	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
120	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
140	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
160	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
180	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
200	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
220	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
240	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
260	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
280	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377
300	43.890	41.751	39.652	37.553	35.454	33.355	33.926	34.496	35.067	35.637	36.208	34.866	33.524	32.182	30.840	29.499	27.627	25.156	23.885	22.014	20.143	18.390	17.617	16.443	15.269	13.777	12.333	10.689	9.045	7.400	5.756	5.207	4.658	4.109	3.560	3.011	2.551	2.282	1.932	1.572	1.212	1.037	0.981	0.865	0.750	0.634	0.583	0.531	0.480	0.428	0.377

Figure 2. Modeling Results (Annual) Table: maximum concentration for each combination of stack height and distance -- HAP reporting thresholds to be based on concentrations caused by stacks no more than 40 feet high and within a distance of no more than 150 feet from stack to property line

2.3 Identifying Proposed Reporting Threshold Values

2.3.1 Concentration Percentile-based Threshold Values

Rather than arbitrarily basing the proposed HAP reporting thresholds on a single stack height/property-line combination, a robust statistical approach was utilized. This approach considered all modeled stack height/property-line distance combinations predicted for stacks no more than 40 ft high and property lines no more than 150 ft from the stack. A percentage frequency distribution of the modeled impacts was evaluated. The resulting percentiles represent conservative concentration scenarios that could reasonably be expected to occur for multiple stack property-line combinations. This subset of data contains normalized air concentration values for more than 570 combinations of stack heights and receptor distances. To generate candidate values of HAP reporting thresholds, the 85th, 90th, 95th and 98th percentiles of the modeled concentrations of this dataset were evaluated. Figure 3 shows the distribution of modeled normalized annual impacts. A percentile identifies the normalized air concentration value where the percentage of modeled impacts in the dataset are less than the indicated air concentration value. Based on this chart, the 98th percentile of normalized annual concentrations is at 37.7 $\mu\text{g}/\text{m}^3$ per ton/year pollutant emission, which represents a highly conservative scenario. Figures 4 shows the data table of combinations of stack height and distances with the 85th, 90th, 95th and 98th percentiles. They are 29.3, 31.6, 34.3 and 37.7 $\mu\text{g}/\text{m}^3$ per ton/year respectively.

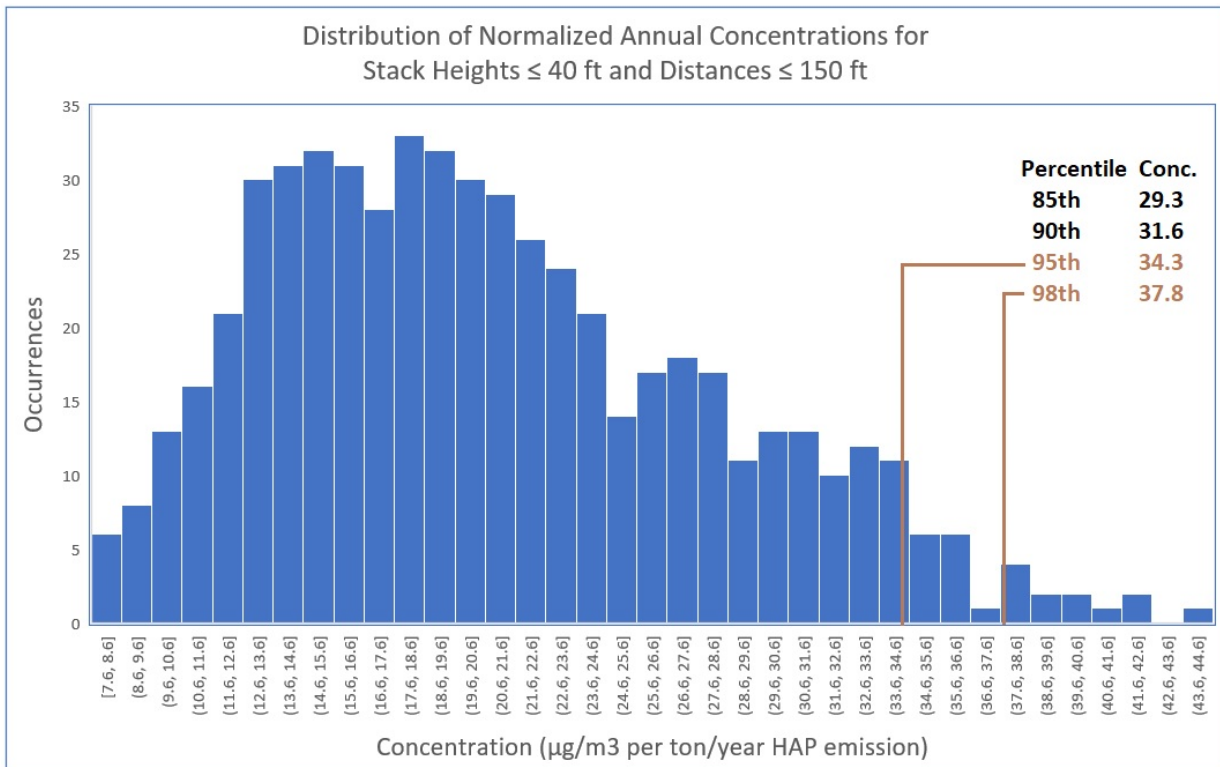


Figure 3. Percentage distribution of normalized annual concentrations

		Stack Height (ft)																								
Distance (ft)	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
20	43.85	41.75	39.65	37.55	35.45	33.36	33.93	34.50	35.07	35.64	36.21	34.87	33.52	32.18	30.84	29.50	28.56	27.63	26.69	25.76	24.82	23.89	22.95	22.01	21.08	20.14
25	42.50	40.50	38.49	36.48	34.48	32.47	33.01	33.54	34.08	34.62	35.16	33.87	32.58	31.30	30.01	28.72	27.82	26.91	26.00	25.10	24.19	23.28	22.38	21.47	20.56	19.66
30	41.16	39.24	37.33	35.41	33.50	31.58	32.09	32.59	33.10	33.60	34.11	32.87	31.64	30.41	29.18	27.95	27.07	26.19	25.31	24.44	23.56	22.68	21.81	20.93	20.05	19.17
35	39.48	37.68	35.87	34.06	32.25	30.45	30.91	31.38	31.85	32.32	32.79	31.62	30.45	29.28	28.12	26.95	26.11	25.27	24.43	23.59	22.75	21.91	21.06	20.22	19.38	18.54
40	37.81	36.11	34.41	32.71	31.01	29.31	29.74	30.17	30.60	31.03	31.46	30.36	29.26	28.16	27.06	25.95	25.15	24.35	23.54	22.74	21.93	21.13	20.32	19.52	18.71	17.91
45	36.04	34.45	32.86	31.27	29.67	28.08	28.48	28.87	29.26	29.66	30.05	29.02	27.98	26.94	25.91	24.87	24.11	23.34	22.57	21.81	21.04	20.28	19.51	18.74	17.98	17.21
50	34.28	32.79	31.31	29.82	28.33	26.85	27.21	27.57	27.93	28.28	28.64	27.67	26.70	25.73	24.76	23.79	23.06	22.33	21.61	20.88	20.15	19.42	18.70	17.97	17.24	16.51
55	32.60	31.21	29.82	28.42	27.03	25.64	25.97	26.30	26.63	26.96	27.29	26.37	25.46	24.55	23.64	22.72	22.03	21.34	20.65	19.96	19.27	18.58	17.89	17.20	16.51	15.82
60	30.92	29.62	28.32	27.03	25.73	24.44	24.74	25.03	25.33	25.63	25.93	25.07	24.22	23.37	22.51	21.66	21.01	20.35	19.70	19.05	18.39	17.74	17.08	16.43	15.78	15.12
65	29.42	28.21	26.99	25.78	24.56	23.35	23.62	23.89	24.16	24.44	24.71	23.91	23.10	22.30	21.49	20.69	20.07	19.45	18.82	18.20	17.58	16.96	16.34	15.72	15.10	14.47
70	27.93	26.80	25.66	24.53	23.39	22.26	22.50	22.75	23.00	23.24	23.49	22.74	21.98	21.23	20.47	19.72	19.13	18.54	17.95	17.36	16.77	16.18	15.59	15.00	14.42	13.83
75	26.69	25.61	24.54	23.47	22.39	21.32	21.55	21.77	22.00	22.22	22.45	21.73	21.02	20.30	19.58	18.87	18.31	17.74	17.18	16.62	16.06	15.50	14.94	14.38	13.81	13.25
80	25.44	24.43	23.42	22.41	21.40	20.39	20.59	20.79	21.00	21.20	21.41	20.73	20.05	19.37	18.70	18.02	17.48	16.95	16.42	15.88	15.35	14.81	14.28	13.75	13.21	12.68
85	24.40	23.43	22.47	21.51	20.54	19.58	19.77	19.96	20.15	20.34	20.53	19.88	19.24	18.59	17.94	17.29	16.78	16.27	15.76	15.25	14.74	14.23	13.72	13.20	12.69	12.18
90	23.36	22.44	21.52	20.60	19.69	18.77	18.95	19.12	19.30	19.48	19.66	19.04	18.42	17.80	17.19	16.57	16.08	15.59	15.10	14.62	14.13	13.64	13.15	12.66	12.17	11.69
95	22.47	21.58	20.70	19.82	18.94	18.05	18.22	18.39	18.56	18.73	18.90	18.31	17.72	17.13	16.53	15.94	15.47	15.00	14.53	14.06	13.59	13.13	12.66	12.19	11.72	11.25
100	21.58	20.73	19.88	19.04	18.19	17.34	17.50	17.66	17.83	17.99	18.15	17.58	17.01	16.45	15.88	15.31	14.86	14.41	13.96	13.51	13.06	12.61	12.16	11.71	11.26	10.81
110	20.36	19.57	18.77	17.97	17.18	16.38	16.52	16.66	16.80	16.94	17.07	16.54	16.01	15.48	14.95	14.41	13.99	13.56	13.14	12.72	12.29	11.87	11.44	11.02	10.59	10.17
120	19.15	18.40	17.66	16.91	16.17	15.42	15.54	15.65	15.77	15.88	16.00	15.50	15.01	14.51	14.01	13.52	13.12	12.72	12.32	11.92	11.52	11.12	10.72	10.32	9.92	9.52
130	17.93	17.24	16.55	15.85	15.16	14.46	14.56	14.65	14.74	14.83	14.92	14.46	14.00	13.54	13.08	12.62	12.25	11.87	11.50	11.12	10.75	10.38	10.00	9.63	9.25	8.88
140	16.72	16.08	15.43	14.79	14.15	13.51	13.57	13.64	13.71	13.78	13.85	13.42	13.00	12.57	12.15	11.72	11.37	11.03	10.68	10.33	9.98	9.63	9.28	8.93	8.59	8.24
150	15.50	14.91	14.32	13.73	13.14	12.55	12.59	12.64	12.68	12.73	12.77	12.38	11.99	11.60	11.22	10.83	10.50	10.18	9.86	9.53	9.21	8.89	8.56	8.24	7.92	7.59

Percentile:

98%	37.68
95%	34.28
90%	31.62
85%	29.31

Figure 4. Annual concentrations for stack height/property line distance combinations at the 85th, 90th, 95th, and 98th percentiles

Normalized hourly concentrations were processed in a similar way to evaluate short-term impacts.

2.3.2 Evaluation Methodology

Equations 1 and 2 below were used to calculate proposed reporting thresholds for emissions of HAP with available inhalation exposure toxicity data [2]. The normalized annual air impact values (C' in the equations) were obtained from Figure 3. Impact values at the 85th, 90th, 95th and 98th percentiles were used in calculations. These percentile impact values represent the concentrations from multiple combinations of stack heights and distances to property line that are expected to occur in conservative scenarios when one ton per year of a HAP is emitted. Unit risk factors (URF) and reference concentrations (RfC) used in the equations are based on toxicity data from the latest updates of US EPA Integrated Risk Information System [3], CalEPA Toxicity Criteria Database [4], and Agency for Toxic Substances and Disease Registry "Minimal Risk Levels for Hazardous Substances" [5]. Refer to the Department's Risk Screening Workbook for the URF and the RfC values. Using the normalized annual impacts (C') and the HAP specific URF and/or RfC, the candidate value of the reporting threshold (Q) was calculated.

Cancer based Threshold

$$\text{Equation 1: } Q = \frac{CR}{URF \times C'}$$

Non-Cancer based Threshold

$$\text{Equation 2: } Q = \frac{HQ \times RfC}{C'}$$

where:

Q = maximum annual emission rate, ton/yr – **Threshold**

CR = cancer risk; capped at 1×10^{-6}

URF = pollutant-specific inhalation Unit Risk Factor, $(\mu\text{g}/\text{m}^3)^{-1}$

HQ = non-cancer risk Hazard Quotient; capped at 1

RfC = pollutant-specific Reference Concentration, $\mu\text{g}/\text{m}^3$

C' = normalized annual concentration, $(\mu\text{g}/\text{m}^3)/(\text{ton}/\text{yr})$; for example, use the value at 95th percentile.

2.3.3 Risk Guidelines for the Proposed HAP Reporting Thresholds

The cancer risk (CR) guideline for a HAP from a single source was determined as a risk of less than or equal to **one in a million (0.000001)**. The non-cancer risk guideline for a HAP was determined as a Hazard Quotient (HQ) **less than or equal to one (1)**. Risks at and below these levels are considered negligible. Cancer risk-based threshold candidate values were compared to long-term non-cancer risk threshold candidate values for those HAPs that have both carcinogenic and non-carcinogenic impacts in order to select a more stringent value. These values were also analyzed to ensure that no threshold would cause a short-term non-cancer risk with HQ above 1 if a HAP has short-term non-cancer toxicology data available.

The following principles were followed to develop the HAP reporting thresholds.

1. The maximum HAP reporting threshold is capped at 2000 pounds per year for any HAP even if the calculations by Equation 1 or 2 give a value above 2000.
2. 13 HAPs have reporting thresholds based on short-term toxicity data as these either showed a non-negligible risk for a short-term exposure when compared to long-term values or do not have long-term toxicity data available. See Appendix A for this list.
3. Certain HAPs, such as arsenic, cadmium, and chromium, are listed as “Chemical Compound Groups” (classes). These listings are defined as including any unique chemical substance that contains the named chemical (i.e., antimony, arsenic, etc.) as part of that chemical’s molecular structure. When a compound or subgroup is individually listed under a group, the reporting threshold for the compound or subgroup takes precedence over the threshold listed for the chemical group. Also, no individual compound or subgroup within a chemical group should have a higher reporting threshold than its chemical group.

Table 3 shows examples of HAPs with percentile-based candidate threshold values and how a value for the reporting threshold is proposed.

Table 3. Examples of Proposed Reporting Thresholds

HAP	Percentile Based Thresholds (lbs/year)				Candidate Value for Reporting Threshold (lbs/year)
	85th	90th	95th	98th	
Benzene	8.7	8.1	7.5	6.8	7.0
Carbon Tetrachloride	11.4	10.5	9.7	8.8	9.0
Chloroform	3	2.75	2.5	2.3	2.3
Formaldehyde	5.3	4.9	4.5	4.1	4.0
Hydrogen Fluoride	955	885	816	743	740
Methyl Bromide	341	316	292	265	265
Vinyl Chloride	7.8	7.2	6.6	6.0	6.0
Vinyl Acetate	13647	12650	11669	10616	2000

2.3.4 Comparison with Current AMR VI Guidelines

The current AMR VI (1981) does not have HAP reporting thresholds. In the guideline document for this version of the regulation, however, recommended ambient concentrations were established for the HAPs. For comparison, the maximum ambient concentration for a HAP was calculated based on the new methodology described above (Section 2.3.2). For example, if a HAP has cancer Unit Risk Factor (URF) equal to $0.0000002 / (\mu\text{g}/\text{m}^3)$ and if the negligible cancer risk (CR) level is set at 0.000001 (1 in a million), the maximum annual ambient concentration of this HAP is: $C = \text{CR}/\text{URF} = 0.000001 / 0.0000002 = 5 (\mu\text{g}/\text{m}^3)$.

Table 4 shows examples of how the recommended ambient concentrations in the current AMR VI guidelines are compared with the maximum concentrations based on the new methodology.

Table 4. Recommended ambient concentrations in current AMR VI (1981) guidelines compared with maximum concentrations based on new methodology

HAP	Current AMR VI - Recommended Annual Ambient Concentration		Max. Annual Concentration ($\mu\text{g}/\text{m}^3$) by a source based on new methodology -- cancer risk at 1/million & non-cancer HQ at 1
	(ppb)	($\mu\text{g}/\text{m}^3$)	
Benzene	24	76.6	0.13
Methyl Bromide	120	466	5.0
Formaldehyde	4.8	5.9	0.077
Carbon tetrachloride	12	75.6	0.17
Chloroform	24	116.8	0.043
Vinyl chloride	2.4	6.1	0.11
Chromium/compounds (VI)		0.12	0.00008

These and other comparisons indicate that the new methodology provides higher levels of protection than the recommended ambient concentrations in the current AMR VI guidelines.

2.3.5 Comparison with New Jersey Reporting Thresholds

The methodology used here to establish the reporting thresholds is very similar to that used by the New Jersey Department of Environmental Protection to determine HAPs reporting thresholds in the New Jersey air toxics regulation. Understandably the threshold values selected for Philadelphia are quite similar to those in the New Hersey regulation, as shown in Table 5.

Table 5. Example of Philadelphia HAP Reporting Thresholds Compared with New Jersey Thresholds

HAP	Threshold Value based on Philadelphia Scenarios (lbs/year, at 98 th percentile)	New Jersey Reporting Threshold (lbs/year)
Benzene	6.8	6
Methyl bromide	265	230
Formaldehyde	4.1	3.5
Hydrogen fluoride	743	600
Carbon tetrachloride	8.8	8
Chloroform	2.3	2
Vinyl Acetate	2000	2000
Vinyl Chloride	6	5
Acetaldehyde	24	21

III. Risk Screening Workbook

The above-described methodology was also used in developing the *Risk Screening Workbook*. It is a Microsoft Excel workbook that calculates the worst-case scenario cancer and non-cancer risks based on user input data, built-in worst-case HAP concentrations derived from air quality modeling, and URF and RfC values of the HAPs. Therefore, it is an easy-to-use tool that simplifies the screening process for the permit applicant. See Section III of the *Technical Guidelines for Air Management Regulation VI* and the spreadsheet file for more information.

References:

1. US EPA HAP list: <https://www.epa.gov/haps/initial-list-hazardous-air-pollutants-modifications>
2. New Jersey DEP Guidance on Risk Assessment for Air Contaminant Emissions” (<http://www.state.nj.us/dep/aqpp/downloads/techman/1003.pdf>)
3. US EPA Integrated Risk Information System (IRIS, www.epa.gov/iris)
4. CalEPA Toxicity Criteria Database (oehha.ca.gov/tcdb/index.asp)
5. Agency for Toxic Substances and Disease Registry “Minimal Risk Levels for Hazardous Substances” (MRLs, <https://www.atsdr.cdc.gov/minimalrisklevels/index.html>).

Appendix A

List of Reporting Thresholds Based on Short-Term Toxicity Data

CAS #	Chemical Compound	Proposed Threshold (lbs/year)
75150	Carbon disulfide	2000
75003	Ethyl chloride	2000
111762	Ethylene glycol monobutyl ether	2000
110805	Ethylene glycol monoethyl ether (2-Ethoxy ethanol)	1800
111159	Ethylene glycol monoethyl ether acetate	685
109864	Ethylene glycol monomethyl ether (2-Methoxy ethanol)	455
7783075	Hydrogen selenide	25
	Manganese and compounds	0.8
67561	Methanol	2000
71556	Methyl chloroform	2000
108101	Methyl isobutyl ketone	2000
108883	Toluene	2000
79016	Trichloroethylene	10