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Methodology and Assumptions Used to Generate the Revised Level-1 Air Impact Values for the NJDEP Risk Screening Worksheet

The Bureau of Technical Services (BTS) has revised the Department's level-1 risk assessment air impact values for the NJDEP Division of Air Quality Risk Screening Worksheet, used to estimate risk from the emissions of hazardous air pollutants (HAPs). The level-1 risk assessment model predictions were last revised in August 1994. These revised level-1 impact predictions incorporate a number of improvements over the current values used. These include:

- The U.S. Environmental Protection Agency's (EPA) new guideline model AERMOD was used to predict HAP concentrations. AERMOD is a much more sophisticated dispersion model than those used to generate the level-1 risk assessment model predictions in 1994 (ISCLT2 and SCREEN2).

- AERMOD contains an improved building downwash algorithm known as PRIME. Unlike the previous 1994 modeling, HAP concentrations in the building cavity region will be predicted by AERMOD.

- The 1994 air impact values had a discontinuity between impact estimates for stacks 30 ft and less and those greater than 30 ft. This discontinuity has been eliminated in the revised level-1 risk assessment.

- Impacts as a function of distance from the stack are now available for stacks greater than 30 ft in height. The previous 1994 level-1 risk assessment predictions were independent of stack distance and only provided the maximum modeled impact for stacks greater than 30 ft.

Below is a summary of the methodology and assumptions used to generate the revised level-1 risk assessment air impact values for the Risk Screening Worksheet for point sources.

Dispersion Model
Initial model runs were made with AERMOD Version 04300. Later runs were made with AERMOD Version 07026.

Land Use
AERMOD was run in both the rural and urban modes. In the urban mode a population parameter of 1,000,000 was used.

Meteorological Data
The 1992 and 1993 meteorological data from two different surface National Weather Service stations were used. One site was the Newark International Airport and the other was the Philadelphia International Airport. Both data sets used concurrent upper air data from Atlantic City.

Stack Parameters and Emission Rates
The stack parameters and emission rates used to generate the normalized air impact values are listed in Table 1. The stack exit velocity and exit temperature values were selected so that plume rise would be minimal. Emissions were assumed to occur 24 hours per day, 365 days per year. The stack was located in the middle of the building.

Table 1. Stack Parameters and Emission Rates

Parameter	Value
Annual Emission Rate	1 ton/year (0.23 lb/hr)
24-Hour Emission Rate	1 lb/hr
Stack Heights (ft)	10, 15, 20, 25, 30, 40, 50, 75, 100, 150, 200, 250
Stack Diameter	1 ft (0.305 m)
Exit Velocity	0.33 ft/sec (0.1 m/sec)
Exit temperature	80^{o}F (300^{o}K)

Building Downwash
The building dimensions were selected so that the plume was subjected to significant amounts of downwash. The building dimensions used are listed in Table 2. All stacks were well below the GEP stack height of 2.5 times higher than the building height. For stacks between 10 and 20 ft, the stack was assumed to be a factor of 1.25 times higher than 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 higher than the building height. For stack heights between 10 and 50 ft, the building's horizontal dimensions were assumed constant at 50 ft. As stack heights increased above 50 ft, the building's horizontal dimensions were allowed to also increase. The assumed building's horizontal dimensions are also shown in Table 2.

The EPA's Building Profile Input Program (BPIP-PRIME) was used to generate building dimensions for input into AERMOD.

Table 2. Stack Heights and Assumed Building Dimensions

Stack Height (ft)	Building Height (ft)	Building Width and Length (ft)
10	8	50 x 50
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

Receptor Grid

Modeling was performed assuming flat terrain. A polar receptor grid was used centered on the stack (midpoint of the building) with 36 radials spaced every 10 degrees. The spacing of receptors along the radials were as follows: 40 ft, 50 ft, 60 ft, 70 ft, 80 ft, 90 ft, 100 ft, 150 ft, 200 ft, 250 ft, 300 ft, 500 ft, 750 ft, and 1000 ft. For buildings with horizontal dimensions larger than 75 ft by 75 ft the model predictions at receptors within the building were ignored.

Modeling Methodology

The AERMOD model was run with EPA's regulatory default parameters and the parameters discussed above.

AERMOD's 24-hour predictions were converted to shorter term averaging times using results found by the AERSCREEN Workgroup. The conversion factors for the 24-hour predictions are as follows: 2.5 for 1 hour, 2.3 for 4 hours, 2.0 for 6 hours, and 1.75 for 7 and 8 hours.

Modeling Results

For most stack heights modeling in the rural mode gave nearly identical results as those predicted in the urban mode. Below in Table 3 is a summary of the worst-case scenario for each stack height and each averaging time.

The normalized annual air impact values as a function of stack height (10 to 250 ft) and distance from the stack (out to 1000 ft) are listed in Table 4. As shown in the table, these modeled impacts are for the most part greater than the values from the 1994 modeling. In the Risk Screening Worksheet, the normalized annual concentration obtained using a 1 ton/year emission rate will be multiplied by the source's annual ton per year HAP emission rate in order to predict a long-term HAP concentration. These concentrations are then used to estimate cancer risk and long-term hazard indices. Only those stack

heights and distances explicitly listed in Table 4 were modeled for annual impacts. When other stack height or distance from the stack values are input into the Risk Screening Worksheet, linear interpolation is used to estimate the air impact value for that stack height and/or distance from the stack.

The normalized 24-hour air impact values as a function of stack height (10 to 250 ft) and distance from the stack (out to 1000 ft) are listed in Table 5. As shown in the table, these modeled impacts are for the most part less than the values from the 1994 modeling.

In the Risk Screening Worksheet, the normalized 24-hour concentration obtained using a 1 lb/hour emission rate will be multiplied by the source's allowable lb/hr HAP emission rate in order to predict a short-term HAP concentration. These concentrations and the conversion factors listed earlier are then used as a basis for estimating short-term hazard indices (1-24 hours). Only those stack heights and distance explicitly listed in Table 4 were modeled for 24-hour impacts. When other stack height or distance from the stack values are input into the worksheet, linear interpolation is used to estimate the normalized concentration for that stack height or distance from the stack.

Table 3. Worst-Case Impact Scenarios

Stack Height (ft)	Annual Average Conc.	24-Hour Average Conc.
10	Philadelphia 1993 met., Rural, 110° radial	Newark 1993 met., rural, 190° radial
15	Philadelphia 1993 met., Rural, 110° radial	Philadelphia 1992 met., rural, 210° radial
20	Philadelphia 1993 met., Rural, 120° radial	Philadelphia 1992 met., urban, 250° radial
25	Philadelphia 1993 met., Urban, 120° radial	Philadelphia 1992 met., urban, 250° radial
30	Philadelphia 1993 met., Urban, 120° radial	Philadelphia 1992 met., urban, 250° radial
40	Philadelphia 1993 met., Urban, 100° radial	Philadelphia 1992 met., urban, 250° radial
50	Philadelphia 1993 met., Urban, 100° radial	Philadelphia 1992 met., rural, 250° radial
75	Philadelphia 1993 met., Urban, 100° radial	Philadelphia 1992 met., Rural, 250° radial
100	Philadelphia 1993 met., urban, 100° radial	Philadelphia 1992 met., urban, 250° radial
150	Philadelphia 1993 met., urban, 100° radial	Philadelphia 1993 met., urban, 50° radial
200	Philadelphia 1993 met., urban, 100° radial	Philadelphia 1993 met., urban, 50° radial
250	Philadelphia 1993 met., Urban, 100° radial	Philadelphia 1993 met., urban, 50° radial

Table 4.
Normalized Annual Air Impact Values per ton/yr of Emissions for Stack Heights 10–250 ft [a] (ug/m^3)

Distance (ft)	10 ft	15 ft	20 ft	25 ft	30 ft	40 ft	50 ft	75 ft	100 ft	150 ft	200 ft	250 ft
40	***162.77***	***80.6***	***47.7***	***29.58***	***18.84***	***9.13***	***4.83***	***2.64***	***1.144***	***0.444***	***0.234***	***0.09***
50	***135.61***	***66.7***	***38.7***	***24***	***15.23***	***7.68***	***4.03***	***2.55***	***1.144***	***0.444***	***0.234***	***0.09***
60	***86.07***	***56***	***32.8***	***20.34***	***12.64***	***6.51***	***3.37***	***2.44***	***1.094***	***0.444***	***0.234***	***0.09***
70	***50***	***34.5***	***28.4***	***17.82***	***11.22***	***5.53***	***2.81***	***2.29***	***1.033***	***0.444***	***0.234***	***0.09***
80	***24.42***	***17.8***	***15***	***12.45***	***8.92***	***4.5***	***2.39***	***2.1***	***0.959***	***0.444***	***0.234***	***0.09***
90	20.32	***14.7***	***10.8***	7	5.48	***3.21***	***2***	***1.92***	***0.873***	***0.43***	***0.234***	***0.09***
100	17.25	12.7	***9.5***	6.22	4.36	***2.28***	**1.8**	***1.77***	***0.798***	***0.415***	***0.234***	***0.09***
150	9	7.1	5.7	4.06	3.11	1.72	**1.3**	***1.19***	***0.518***	***0.315***	***0.204***	***0.078***
200	5.41	4.5	3.8	2.86	2.37	1.48	0.79	***0.56***	***0.285***	***0.235***	***0.163***	***0.062***
300	2.6	2.3	2	1.57	1.45	1.1	0.7	***0.43***	***0.19***	***0.12***	***0.106***	***0.038***
400	1.4	1.3	1.2	0.96	0.96	0.8	0.57	***0.35***	***0.176***	***0.085***	***0.062***	***0.023***
500	0.83	0.85	0.79	0.65	0.67	0.61	0.465	0.29	***0.16***	***0.081***	***0.047***	***0.015***
750	0.32	0.35	0.33	0.29	0.32	0.33	0.27	0.19	0.124	***0.067***	***0.043***	***0.019***
1000	0.19	0.19	0.18	0.18	0.18	0.2	0.18	0.14	0.095	***0.055***	***0.036***	***0.02***

a. Concentrations in bold italic higher than 1994 level-1 risk assessment impacts.

Table 5.
Normalized 24-Hour Air Impact Values per lb/hr of Emissions for Stack Heights 10–250 ft [a] (ug/m^3)

Distance (ft)	10 ft	15 ft	20 ft	25 ft	30 ft	40 ft	50 ft	75 ft	100 ft	150 ft	200 ft	250 ft
40	***4470***	***1611***	***980***	***603***	***349***	160	85.7	33.1	17.6	7.0	3.7	1.7
50	***3937***	***1453***	***935***	***577***	***337***	156	83.2	33.1	17.6	7.0	3.7	1.7
60	1885	***1352***	***896***	***556***	***325***	151	80.8	32.8	17.6	7.0	3.7	1.7
70	825	928	786	***505***	***316***	146	78.1	32.1	17.6	7.0	3.7	1.7
80	671	377	468	327	247	140	75.2	31.5	17.3	7.0	3.7	1.7
90	578	323	345	228	159	109	68.6	30.8	17.1	7.0	3.7	1.7
100	503	286	313	211	145	74.0	57.4	30.1	16.8	7.0	3.7	1.7
150	281	162	213	153	115	63.6	40.9	22.5	15.4	6.6	3.7	1.7
200	173	105	152	115	91.9	57.2	41.4	16.1	11.2	6.0	3.5	1.6
300	91.2	52.5	84.7	68.1	58.6	42.5	33.8	16.2	7.6	4.4	3.1	1.5
400	49.3	29.8	56.1	47.5	42.6	32.9	27.3	14.1	7.4	2.9	2.4	1.4
500	24.9	18.8	39.3	33.1	31.1	25.7	22.2	12.2	6.7	2.8	1.6	0.8
750	8.6	6.7	16.4	14.7	15.3	14.7	14.4	8.2	5.5	2.1	1.4	0.9
1000	4.9	3.0	7.1	7.0	7.8	8.3	9.6	6.3	4.5	1.5	1.1	0.8

a. Concentrations in bold italic higher than 1994 level-1 risk assessment impacts.

Conservatism in the Modeling of the Level-1 Air Impact Values and Risk Screening Worksheet

- The highest impact predicted from either the urban or rural mode was used for the level-1 risk assessment.

- The highest impact predicted from any of the four years of modeled meteorological data was used.

- Of the 36 wind directions modeled, the direction for which the receptor radial had the highest concentrations was selected.

- Minimal plume rise was assumed.

- All stack heights were well below their GEP stack heights and subject to large amounts of building downwash.

- The stacks were located in the center of the building. When evaluating all wind directions, this location will produce the maximum amount of downwash.

- Emissions were assumed to occur continuously 24-hours a day, 365 days a year.