Appendix E

Stationary Diesel-Fueled Engines
Health Risk Assessment Methodology

Introduction

This appendix presents the methodology used to estimate the potential cancer risk from exposure to diesel particulate matter (PM) emitted from diesel-fuel stationary engines. The methodology was developed to assist in development of the *Stationary Diesel-Fueled Engine Airborne Toxic Control Measure (ATCM)*.

The estimated risks and assumptions used to determine these risks are not based on a specific engine location or operating parameters. Instead, general assumptions bracketing a fairly broad range of possible operating scenarios were used.

Exposures were estimated at varying downwind distances, including the "point of maximum impact" (PMI) as determined using air dispersion modeling. The estimated risk ranges are used to provide a "qualitative" assessment of the potential risk levels near operating stationary diesel-fueled engines. Actual risk levels will vary due to site specific parameters, including horsepower rating and configuration of the engine, emission rates, operating schedules, site configuration, site meteorology, and distance to receptors.

Source Description

The following methodology was developed to provide estimates of the potential cancer risk associated with exposures to diesel PM emissions from stationary diesel-fueled engines.

Stationary diesel-fueled engines are generally categorized as either prime engines or emergency back-up engines. Prime engines are used to power equipment such as compressors, cranes, generators, pumps, and grinders. Emergency back-up engines are used solely for emergency back-up electric power generation or water pumping. The main difference between prime and emergency back-up engines is that prime engines usually operate considerably more hours per year.

The methodology used in this risk assessment is consistent with the Tier-1 analysis presented in the draft Office of Environmental Health Hazard Assessment (OEHHA), Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments (OEHHA, 2002a). The OEHHA draft guidelines and this assessment utilize health and exposure assessment information that is contained in the Air Toxics Hot Spot Program Risk Assessment Guidelines, Part II, Technical Support Document for Describing Available Cancer Potency Factors (OEHHA 2002b); and the Air Toxics Hot Spot Program Risk Assessment Guidelines, Part IV, Technical Support Document for Exposure Analysis and Stochastic Analysis (OEHHA 2000), respectively.

Modeling Assumptions

For this modeling exercise we used a matrix of parameters. We modeled engines of 200, 550, and 1500 horsepower, and varied both the emissions rate and the hours of operation for each horsepower rating. For each engine horsepower, we modeled five diesel PM emission factors: 0.01, 0.15, 0.40, 0.55, and 1.0 grams/brake hp-hour. We also varied the hours of operation and evaluated the risks for the following hours of operation: 10, 20, 30, 40, 50, 100, 200, 300, 400, 500, and 1000 hours/year. For each case we calculated the risk at varying downwind distances.

Model Used

The PM emissions are modeled in this scenario using the United States Environmental Protection Agency's Industrial Source Complex Short Term Model – Version 3 (ISCST3 Date: 00101). The ISCST3 is an air dispersion model that allows an estimation of the annual average above ambient diesel PM concentrations.[1] The potential cancer risk to nearby residential receptors is obtained by multiplying annual average above ambient concentration of diesel PM by the unit risk factor (URF) for diesel PM (300 excess cancers/ug/m^3 over a 70-year exposure period). The results are expressed as an estimate of potential cancer risk in chances per million.

Meteorological Data

Meteorological data are site-specific parameters that are used in air dispersion models to calculate concentrations of emissions and subsequent risk. For this scenario, West Los Angeles, 1981, meteorological data were selected as the input to the ISCST3 model. The West Los Angeles meteorological data tend to provide higher estimates of risk than most of the other meteorological data sets compiled by ARB. This is because the West Los Angeles site tends to have the lowest average wind speed and more persistent wind directions, which result in less dispersion of pollutants.

Model Parameters and Emission Factors

The key modeling parameters and emission factors are presented in Table 1. We used the rural dispersion coefficient to provide a more conservative (higher) estimate of the predicted concentration and the estimated potential cancer risk.

[1]The pollutant concentrations obtained from this modeling exercise that are used to estimate cancer risk do not include the background (or ambient) levels of the modeled pollutant. The final risk value is determined by multiplying the modeled pollutant concentration by the Unit Risk Factor (URF), as determined by ARB and the Office of Environmental Health Hazard Assessment (OEHHA).

Table 1: Modeling and Health Risk Assessment Parameters

Modeling Paramenters	
Model	ISCST3 (Version 00101)
Engine Horsepower (at 100% load)	200 HP, 550 HP, 1500 HP
Engine Operation Load	75%
Emission Factor	0.01, 0.15, 0.40, 0.55, 1.00 g/bhp-hr
Operation Hours (annual)	10, 20, 30, 40, 50, 100, 200, 300, 400, 500, 1000
Source Type	Point
Dispersion Setting	Rural
Receptor Height	1.5 m
Stack Information:	
Stack Diameter	4 in, 6 in, and 13 in
Stack Height	3 m
Stack Temperature	622 K
Stack Exhaust Velocity	59.8 m/s, 73.1 m/s, and 42.5 m/s
Time Emissions Emitted	3 p.m.
Meteorological Data	West L. A. (1981)
Release Height	Same as the stack height
Health Risk Assessment Parameters	
Receptor's Hypothetical Exposure Time	70 years, 50 weeks per year
Adult Daily Breathing Rate Range	271 - 393 l/kg body weight -day [1]
Adult Body Weight	70 kg
Diesel PM Unit Risk Factor	300 excess cancers/μg/m^3

1. The low end of the breathing rate range is the mean of the OEHHA breathing rate distribution and the high end is the 95th percentile of the distribution

Results

We have included three sets of tables, one set for each modeled horsepower (200, 500, and 1500). Each set of tables contains five sub-tables, one for each emission factor (0.01, 0.15, 0.40, 0.55 and 1.0 g/bhp-hr). Each emission factor table comprises a matrix of downwind distances and hours of operation, with the calculated risks for each combination. The low-end and high-end of the risks presented in the tables are corresponding to the 65th (mean) and 95th percentile breathing rates, respectively. Additionally, the tables are coded using varied levels of shading. The moderately shaded squares denote the low-end potential cancer risks of between one and ten per one million people. The darkest squares show the low-end risk levels between 11 and 100 potential cancer cases per million. The white squares show the highest calculated risks, those exceeding 100 potential cases per million people. As can be seen, the estimated cancer risk from stationary diesel-fueled engines varies depending on the emission rate, horsepower and annual hours of operation for a given engine.

Estimated risk as a function of emission factor:

For the range of engine horsepowers modeled, all those engines that emitted 0.01 g/bhp-hr or less could run at least 1000 hours per year without exceeding the lowest range of estimated risks, those of 10 or less potential cancer cases per year.

For the 0.15 g/ bhp-hr engines, most combinations of horsepower, hours of operation and downwind distance did not exceed the lowest range of risks, with those combinations resulting in the higher risk ranges occurring at 200-plus operating hours and low to moderate downwind distances.

For engines with emissions of 0.4 g/bhp-hr or more the trend was to find higher risks at low to moderate downwind distances and longer operating times continues, with the proportion of moderate to high risk level results increasing as emission factors increase.

Estimated risk as a function of hours of operation:

Generally, as the hours of operation increased, the number of engines that exceeded the lowest risk range increased. However, most engines could operate for 10 to 20 hours per year without exceeding the lowest range of risk.

Estimated risk as a function of horsepower:

For the engine configurations evaluated in these scenarios, the smaller horsepower engine (200 hp), typically demonstrated higher near source risk for a given number of hours of operation than the larger engines. In addition, the potential cancer risk reached the point of maximum impact more rapidly for the 200 hp engine than the larger engines. The larger engines had the point of maximum impact further from the engine due to the greater plume dispersion that occurs with the large horsepower engines.

Table Set 1: Diesel Exhaust PM Risk (Potential Cancer Cases in A Million) for 200 HP Engines

	EF = 0.01 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	**42**	75	100	200	300	400	500	800	1600	3200
10	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0
50	0	0-1	0	0	0	0	0	0	0	0	0
100	1-1	1-1	0-1	0	0	0	0	0	0	0	0
200	1-2	1-2	1-1	0-1	0	0	0	0	0	0	0
300	2-2	2-3	1-2	1-1	0	0	0	0	0	0	0
400	2-3	3-4	2-2	1-1	0	0	0	0	0	0	0
500	3-4	4-5	2-3	1-2	0-1	0	0	0	0	0	0
1000	6-8	7-10	4-5	2-3	1-1	1-1	0-1	0	0	0	0

	EF = 0.15 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	**42**	75	100	200	300	400	500	800	1600	3200
10	1-1	1-2	1-1	0-1	0	0	0	0	0	0	0
20	2-2	2-3	1-2	1-1	0	0	0	0	0	0	0
30	3-4	3-5	2-2	1-2	0-1	0	0	0	0	0	0
40	3-5	4-6	2-3	1-2	1-1	0	0	0	0	0	0
50	4-6	5-8	3-4	2-3	1-1	0-1	0	0	0	0	0
100	8-12	11-15	6-8	4-5	1-2	1-1	1-1	0-1	0	0	0
200	17-24	21-31	11-16	7-10	3-4	2-2	1-2	1-1	0-1	0	0
300	25-36	32-46	17-25	11-15	4-6	2-3	2-2	1-2	1-1	0-1	0
400	33-49	42-61	23-33	14-20	5-7	3-4	2-3	2-2	1-1	0-1	0
500	42-61	53-76	28-41	18-26	6-9	4-5	3-4	2-3	1-2	1-1	0
1000	84-122	105-153	56-82	35-51	13-18	8-11	5-8	4-6	2-4	1-2	1-1

	EF = 0.40 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	**42**	75	100	200	300	400	500	800	1600	3200
10	2-3	3-4	2-2	1-1	0	0	0	0	0	0	0
20	4-6	6-8	3-4	2-3	1-1	0-1	0	0	0	0	0
30	7-10	8-12	5-7	3-4	1-1	1-1	0-1	0	0	0	0
40	9-13	11-16	6-9	4-5	1-2	1-1	1-1	0-1	0	0	0
50	11-16	14-20	8-11	5-7	2-2	1-1	1-1	1-1	0	0	0
100	22-32	28-41	15-22	9-14	3-5	2-3	1-2	1-2	1-1	0	0
200	45-65	56-81	30-44	19-27	7-10	4-6	3-4	2-3	1-2	1-1	0
300	67-97	84-122	45-65	28-41	10-15	6-9	4-6	3-5	2-3	1-1	0-1
400	89-130	112-163	60-87	38-55	14-20	8-12	6-8	4-6	3-4	1-2	1-1
500	112-162	140-203	75-109	47-68	17-25	10-15	7-10	6-8	3-5	2-2	1-1
1000	223-324	280-407	150-218	94-137	34-49	20-29	14-21	11-16	7-10	3-5	2-2

	EF = 0.55 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	**42**	75	100	200	300	400	500	800	1600	3200
10	3-4	4-6	2-3	1-2	0-1	0	0	0	0	0	0
20	6-9	8-11	4-6	3-4	1-1	1-1	0-1	0	0	0	0
30	9-13	12-17	6-9	4-6	1-2	1-1	1-1	0-1	0	0	0
40	12-18	15-22	8-12	5-8	2-3	1-2	1-1	1-1	0-1	0	0
50	15-22	19-28	10-15	6-9	2-3	1-2	1-1	1-1	0-1	0	0
100	31-45	39-56	21-30	13-19	5-7	3-4	2-3	2-2	1-1	0-1	0
200	61-89	77-112	41-60	26-38	9-14	6-8	4-6	3-4	2-3	1-1	0-1
300	92-134	116-168	62-90	39-56	14-20	8-12	6-9	5-7	3-4	1-2	1-1
400	123-178	154-224	83-120	52-75	19-27	11-16	8-11	6-9	4-5	2-3	1-1
500	153-223	193-280	103-150	65-94	23-34	14-20	10-14	8-11	5-7	2-3	1-2
1000	307-446	385-559	206-300	129-188	47-68	28-40	20-29	15-22	9-13	4-6	2-3

	EF = 1.0 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	**42**	75	100	200	300	400	500	800	1600	3200
10	6-8	7-10	4-5	2-3	1-1	1-1	0-1	0	0	0	0
20	11-16	14-20	8-11	5-7	2-2	1-1	1-1	1-1	0	0	0
30	17-24	21-31	11-16	7-10	3-4	2-2	1-2	1-1	0-1	0	0
40	22-32	28-41	15-22	9-14	3-5	2-3	1-2	1-2	1-1	0	0
50	28-41	35-51	19-27	12-17	4-6	3-4	2-3	1-2	1-1	0-1	0
100	56-81	70-102	38-55	23-34	8-12	5-7	4-5	3-4	2-2	1-1	0-1
200	112-162	140-203	75-109	47-68	17-25	10-15	7-10	6-8	3-5	2-2	1-1
300	167-243	210-305	113-164	70-102	25-37	15-22	11-16	8-12	5-7	2-3	1-2
400	223-324	280-407	150-218	94-137	34-49	20-29	14-21	11-16	7-10	3-5	2-2
500	279-405	350-508	188-273	117-171	42-62	25-37	18-26	14-20	8-12	4-6	2-3
1000	558-810	700-1017	375-545	235-341	85-123	50-73	36-52	28-40	16-24	8-11	4-6

Note:

1. The low-end risk is based on the mean breathing rate and high-end risk is based on the 95th percentile breathing rate. These risk values assume an exposure duration of 70 years for nearby residents;
2. Light Shading shows the potential cancer risk >= 10/million; Dark Shading shows the risk betwee 10 and 100 per million; No Shading shows the risk greater than 100 per million.

Table Set 2: Diesel Exhaust PM Risk (Potential Cancer Cases in A Million) for 550 HP Engines

	EF = 0.01 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	50	**70**	100	200	300	400	500	800	1600	3200
10	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0-1	0	0	0	0	0	0	0	0
100	0	1-1	1-1	0-1	0	0	0	0	0	0	0
200	0	1-1	1-1	1-1	0	0	0	0	0	0	0
300	1-1	1-1	1-2	1-1	0-1	0	0	0	0	0	0
400	1-1	1-2	2-2	1-2	0-1	0	0	0	0	0	0
500	1-1	2-2	2-3	2-2	1-1	0	0		0	0	0
1000	2-2	3-5	4-6	3-5	1-2	1-1	0-1	0-1	0	0	0

	EF = 0.15 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	50	**70**	100	200	300	400	500	800	1600	3200
10	0	1-1	1-1	0-1	0	0	0	0	0	0	0
20	1-1	1-1	1-2	1-1	0-1	0	0	0	0	0	0
30	1-1	2-2	2-3	1-2	1-1	0	0	0	0	0	0
40	1-1	2-3	2-4	2-3	1-1	0-1	0	0	0	0	0
50	1-2	3-4	3-4	2-4	1-1	1-1	0-1	0	0	0	0
100	3-4	5-7	6-9	5-7	2-3	1-1	1-1	1-1	0	0	0
200	5-7	10-15	12-18	10-14	4-5	2-3	1-2	1-2	1-1	0	0
300	8-11	15-22	18-27	14-21	5-8	3-4	2-3	2-2	1-1	0-1	0
400	10-15	20-30	25-36	19-28	7-10	4-6	3-4	2-3	1-2	1-1	0
500	13-18	25-37	31-45	24-35	9-13	5-7	4-5	3-4	2-2	1-1	0-1
1000	25-37	51-74	61-89	48-70	18-26	10-15	7-10	5-8	3-5	1-2	1-1

	EF = 0.40 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	50	**70**	100	200	300	400	500	800	1600	3200
10	1-1	1-2	2-2	1-2	0-1	0	0	0	0	0	0
20	1-2	3-4	3-5	3-4	1-1	1-1	0-1	0	0	0	0
30	2-3	4-6	5-7	4-6	1-2	1-1	1-1	0-1	0	0	0
40	3-4	5-8	7-9	5-7	2-3	1-2	1-1	1-1	0	0	0
50	3-5	7-10	8-12	6-9	2-3	1-2	1-1	1-1	0-1	0	0
100	7-10	14-20	16-24	13-19	5-7	3-4	2-3	1-2	1-1	0-1	0
200	14-20	27-40	33-47	26-37	10-14	5-8	4-5	3-4	2-2	1-1	0-1
300	20-29	41-59	49-71	39-56	14-21	8-12	6-8	4-6	2-4	1-2	1-1
400	27-39	54-79	65-95	52-75	19-28	11-16	8-11	6-8	3-5	2-2	1-1
500	34-49	68-99	82-119	64-94	24-35	14-20	9-14	7-10	4-6	2-3	1-1
1000	68-98	136-198	163-237	129-187	48-70	27-40	19-27	14-21	8-12	4-6	2-3

	EF = 0.55 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	50	**70**	100	200	300	400	500	800	1600	3200
10	1-1	2-3	2-3	2-3	1-1	0-1	0	0	0	0	0
20	2-3	4-5	4-7	4-5	1-2	1-1	1-1	0-1	0	0	0
30	3-4	6-8	7-10	5-8	2-3	1-2	1-1	1-1	0	0	0
40	4-5	7-11	9-13	7-10	3-4	2-2	1-2	1-1	0-1	0	0
50	5-7	9-14	11-16	9-13	3-5	2-3	1-2	1-1	1-1	0	0
100	9-14	19-27	22-33	18-26	7-10	4-5	3-4	2-3	1-2	1-1	0
200	19-27	37-54	45-65	35-51	13-19	8-11	5-8	4-6	2-3	1-2	1-1
300	28-41	56-81	67-98	53-77	20-29	11-16	8-11	6-9	3-5	2-2	1-1
400	37-54	75-109	90-131	71-103	26-38	15-22	10-15	8-11	5-7	2-3	1-2
500	46-68	93-136	112-163	89-129	33-48	19-27	13-19	10-14	6-8	3-4	1-2
1000	93-135	187-272	225-326	177-257	66-96	38-55	26-38	20-29	11-17	5-8	3-4

	EF = 1.0 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	50	**70**	100	200	300	400	500	800	1600	3200
10	2-2	3-5	4-6	3-5	1-2	1-1	0-1	0-1	0	0	0
20	3-5	7-10	8-12	6-9	2-3	1-2	1-1	1-1	0-1	0	0
30	5-7	10-15	12-18	10-14	4-5	2-3	1-2	1-2	1-1	0	0
40	7-10	14-20	16-24	13-19	5-7	3-4	2-3	1-2	1-1	0-1	0
50	8-12	17-25	20-30	16-23	6-9	3-5	2-3	2-3	1-2	0-1	0
100	17-25	34-49	41-59	32-47	12-17	7-10	5-7	4-5	2-3	1-1	0-1
200	34-49	68-99	82-119	64-94	24-35	14-20	9-14	7-10	4-6	2-3	1-1
300	51-74	102-148	123-178	97-140	36-52	21-30	14-21	11-16	6-9	3-4	1-2
400	68-98	136-198	163-237	129-187	48-70	27-40	19-27	14-21	8-12	4-6	2-3
500	85-123	170-247	204-297	161-234	60-87	34-50	24-34	18-26	10-15	5-7	2-3
1000	169-246	340-494	409-593	322-468	120-175	68-99	47-69	36-52	21-30	10-14	5-7

Note:

1. The low-end risk is based on the mean breathing rate and high-end risk is based on the 95th percentile breathing rate. These risk values assume an exposure duration of 70 years for nearby residents;
2. Light Shading shows the potential cancer risk >= 10/million; Dark Shading shows the risk betwee 10 and 100 per million; No Shading shows the risk greater than 100 per million.

Table Set 3: Diesel Exhaust PM Risk (Potential Cancer Cases in A Million) for 1500 HP Engines

	EF = 0.01 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	50	100	**132**	200	300	400	500	800	1600	3200
10	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0
30	0	0	0	0	0	0	0	0	0	0	0
40	0	0	0	0	0	0	0	0	0	0	0
50	0	0	0	0	0	0	0	0	0	0	0
100	0	0	0-1	0	0	0	0	0	0	0	0
200	0	0	1-1	1-1	1-1	0	0	0	0	0	0
300	0	0	1-2	1-2	1-1	0-1	0	0	0	0	0
400	0	0-1	1-2	2-2	1-2	1-1	0-1	0	0	0	0
500	0	1-1	2-3	2-3	1-2	1-1	0-1	0	0	0	0
1000	1-1	1-2	4-5	4-6	3-4	1-2	1-1	1-1	0	0	0

	EF = 0.15 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	50	100	**132**	200	300	400	500	800	1600	3200
10	0	0	1-1	1-1	0-1	0	0	0	0	0	0
20	0	0	1-2	1-2	1-1	0-1	0	0	0	0	0
30	0	0-1	2-2	2-3	1-2	1-1	0-1	0	0	0	0
40	0	1-1	2-3	3-4	2-2	1-1	1-1	0-1	0	0	0
50	0-1	1-1	3-4	3-5	2-3	1-2	1-1	0-1	0	0	0
100	1-1	2-2	5-8	6-9	4-6	2-3	1-2	1-1	0-1	0	0
200	2-2	3-5	11-15	13-19	9-12	4-6	3-4	2-3	1-1	0-1	0
300	2-3	5-7	16-23	19-28	13-19	6-9	4-6	3-4	1-2	1-1	0
400	3-4	7-10	21-31	26-37	17-25	9-12	5-8	4-5	2-3	1-1	0-1
500	4-6	8-12	26-38	32-47	21-31	11-15	7-10	5-7	2-4	1-2	1-1
1000	8-11	17-24	53-77	64-93	43-62	21-31	13-19	9-14	5-7	2-3	1-1

	EF = 0.40 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	50	100	**132**	200	300	400	500	800	1600	3200
10	0	0-1	1-2	2-2	1-2	1-1	0-1	0	0	0	0
20	0-1	1-1	3-4	3-5	2-3	1-2	1-1	1-1	0	0	0
30	1-1	1-2	4-6	5-7	3-5	2-2	1-2	1-1	0-1	0	0
40	1-1	2-3	6-8	7-10	5-7	2-3	1-2	1-1	1-1	0	0
50	1-1	2-3	7-10	9-12	6-8	3-4	2-3	1-2	1-1	0	0
100	2-3	4-6	14-20	17-25	11-16	6-8	4-5	3-4	1-2	1-1	0
200	4-6	9-13	28-41	34-50	23-33	11-16	7-10	5-7	3-4	1-2	1-1
300	6-9	13-19	42-61	51-75	34-50	17-25	11-15	8-11	4-6	2-3	1-1
400	8-12	18-26	56-82	68-99	46-67	23-33	14-21	10-15	5-8	2-3	1-2
500	10-15	22-32	70-102	86-124	57-83	28-41	18-26	13-18	7-10	3-4	1-2
1000	20-30	44-64	141-204	171-249	114-166	57-83	35-51	25-37	13-19	6-8	3-4

	EF = 0.55 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	50	100	**132**	200	300	400	500	800	1600	3200
10	0	1-1	2-3	2-3	2-2	1-1	0-1	0-1	0	0	0
20	1-1	1-2	4-6	5-7	3-5	2-2	1-1	1-1	0-1	0	0
30	1-1	2-3	6-8	7-10	5-7	2-3	1-2	1-2	1-1	0	0
40	1-2	2-4	8-11	9-14	6-9	3-5	2-3	1-2	1-1	0	0
50	1-2	3-4	10-14	12-17	8-11	4-6	2-4	2-3	1-1	0-1	0
100	3-4	6-9	19-28	24-34	16-23	8-11	5-7	3-5	2-3	1-1	0-1
200	6-8	12-18	39-56	47-68	31-46	16-23	10-14	7-10	4-5	2-2	1-1
300	8-12	18-27	58-84	71-103	47-69	23-34	15-21	10-15	5-8	2-3	1-2
400	11-16	24-35	77-112	94-137	63-91	31-45	19-28	14-20	7-11	3-5	1-2
500	14-20	30-44	97-140	118-171	79-114	39-57	24-35	17-25	9-13	4-6	2-3
1000	28-41	61-89	193-281	235-342	157-229	78-114	49-71	35-50	18-26	8-11	4-5

	EF = 1.0 g/bhp-hr										
	Downwind Distance (m)										
Hours	30	50	100	**132**	200	300	400	500	800	1600	3200
10	1-1	1-2	4-5	4-6	3-4	1-2	1-1	1-1	0	0	0
20	1-1	2-3	7-10	9-12	6-8	3-4	2-3	1-2	1-1	0	0
30	2-2	3-5	11-15	13-19	9-12	4-6	3-4	2-3	1-1	0-1	0
40	2-3	4-6	14-20	17-25	11-16	6-8	4-5	3-4	1-2	1-1	0
50	3-4	6-8	18-26	21-31	14-21	7-10	4-6	3-5	2-2	1-1	0
100	5-7	11-16	35-51	43-62	29-42	14-21	9-13	6-9	3-5	1-2	1-1
200	10-15	22-32	70-102	86-124	57-83	28-41	18-26	13-18	7-10	3-4	1-2
300	15-22	33-48	106-153	128-186	86-125	43-62	27-39	19-27	10-14	4-6	2-3
400	20-30	44-64	141-204	171-249	114-166	57-83	35-51	25-37	13-19	6-8	3-4
500	26-37	55-80	176-255	214-311	143-208	71-103	44-64	32-46	17-24	7-10	3-5
1000	51-74	111-161	352-511	428-622	286-416	142-206	88-128	63-92	33-48	14-20	7-10

Note:

1. The low-end risk is based on the mean breathing rate and high-end risk is based on the 95th percentile breathing rate. These risk values assume an exposure duration of 70 years for nearby residents;
2. Light Shading shows the potential cancer risk <= 10/million; Dark Shading shows the risk betwee 10 and 100 per million; No Shading shows the risk greater than 100 per million.

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