APPENDIX E

METHODOLOGY FOR ESTIMATING THE POTENTIAL HEALTH IMPACTS FROM DIESEL TRANSPORT REFRIGERATION UNIT ENGINES

Methodology

This appendix presents the methodology used to estimate the potential cancer risk from exposure to diesel particulate matter (diesel PM) from Transport Refrigeration Units (TRU) with diesel engines. This methodology was developed to assist in the development of the proposed *Airborne Toxic Measure for In-Use Diesel-Fueled Transport Refrigeration Units and TRU Generator Sets, and Facilities where TRUs Operate.* The assumptions used to determine these potential cancer risks are not based on TRUs at a specific distribution facility, rather a generic (i.e. example) facility was developed. The source parameters selected include a broad range of possible operating scenarios. These estimated risks are used to provide an approximate range of potential risk levels from diesel TRU engine operations. Actual risk levels will vary due to site specific parameters, including the number of TRUs operating, emission rates, operating schedules, site configuration, site meteorology, and distance to receptors.

The methodology used in this risk assessment is consistent with the Tier-1 analysis presented in the draft OEHHA, Air Toxics Hot Spots Program Risk Assessment Guidelines: The Air Toxics Hot Spots Program Guidance Manual for Preparation of Health Risk Assessments (OEHHA, 2003). These 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, 2003); and the Air Toxics Hot Spot Program Risk Assessment Guidelines, Part IV, Technical Support Document for Exposure Analysis and Stochastic Analysis (OEHHA 2000), respectively.

The cancer health risk estimates provide “qualitative” assessment of the potential impacts due to the operation of diesel TRUs. Actual cancer health risks will depend on actual site specific parameters, including number of diesel TRUs operating at the facility, diesel particulate emission rates, facility operation schedules and configuration, and site meteorology. Actual risk will also vary depending on the distance a receptor is from the facility, the duration of exposure, and the inhalation rate.

A. Source Description

Potential cancer health risks due to diesel TRU operations are from emissions of diesel particulate matter (diesel PM). For these analyses, the emission sources were characterized as area sources where trailers equipped with diesel TRUs were expected to operate. Sensitivity studies were done to show that the point of maximum impact, usually the property boundary, shows little difference between characterizing the emissions as an area source comprised all TRU emissions or as numerous small point sources. These studies are shown in Appendix F.

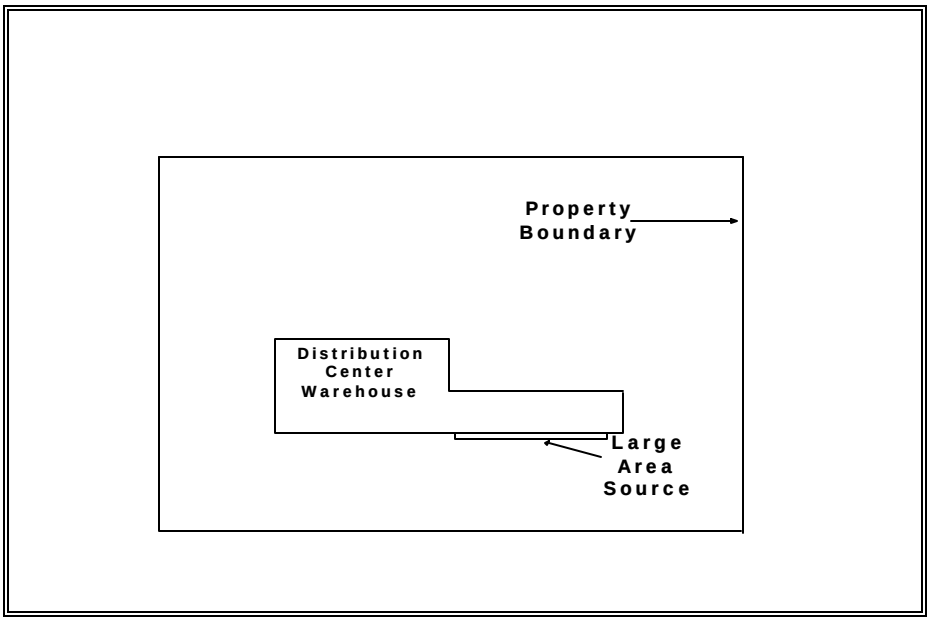
The area source is modeled where the trailers sit while pulling down the trailers’ interior temperature, filling the trailer with perishables, or delivering perishable goods. The distribution center sources were characterized as small, medium, and large areas of emissions. This section describes the parameters and results from the large distribution

center area source (Figure 1). This figure is only given as an illustration of the modeling layouts and is not to scale.

The diesel TRUs operating within the large area source were assumed to be 35 horsepower (hp) with a 60 percent load factor and engine run time (no cycle-off time) as shown in Table 2 through Table 6. The hourly emission rate was conservatively assumed to be 0.7 grams per hp-hour (g/hp-hr), which is slightly less than the ARB year 2000 OFFROAD composite average model emission rate. Analyses were also developed using other diesel PM emission rates, including 1.0, 0.3, 0.22, and 0.02 g/hp-hr. Operation of the diesel TRUs within the area source was assumed to occur between 2 PM and 7AM, 7 days per week.

Sensitivity studies were done to determine buoyancy and final plume height achieved due to stack gas temperature and upward velocity. These studies led to the determination of a daytime and nighttime plume height used for the initial area source height, as shown in Table 1.

Figure 1 Distribution Area Source



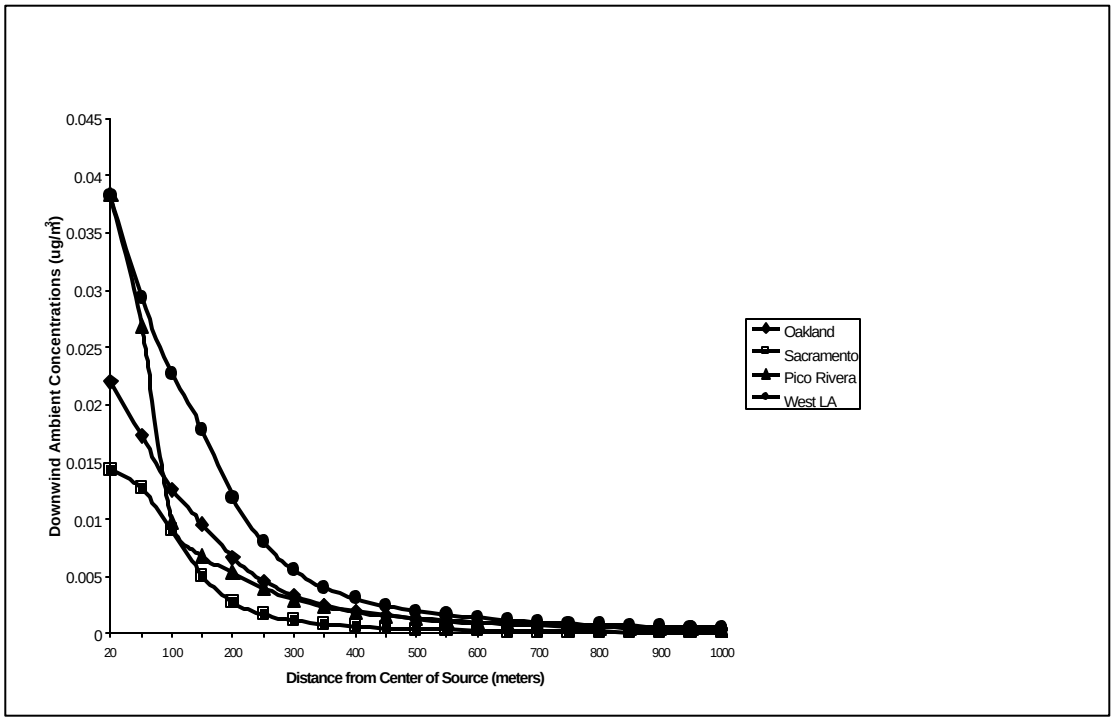
B. Dispersion Modeling Methods

The dispersion of the diesel PM emissions was estimated using the United States Environmental Protection Agency (U. S. EPA) ISCST3. ISCST3 can estimate potential ambient annual average concentrations of diesel PM as a result of diesel PM emissions from area sources.

The analyses used actual meteorological data collected at the West Los Angeles meteorological site during 1981. The West Los Angeles meteorological data provides a more conservative estimate of risk than most of the other 30 meteorological data sets

available to ARB because this site tends to have lower average wind speeds predominantly from the same direction resulting in less dispersion of pollutants. Other representative meteorological data reviewed for these analyses include Sacramento, Oakland, and Pico Rivera. Figure 2 shows a comparison of maximum concentrations for the 4 meteorological data sets used for this assessment.

Figure 2 Comparison of Downwind Ambient Concentrations based on Four Meteorological Data Sets Used



Polar coordinate receptors were placed at specific incremental distances from the area sources to determine the maximum off-site impacts. For the large area source, receptors were placed at 50 meter increments from 100 meters to 500 meters and at 100 meter increments from 500 meters to 800 meters. Table 1 shows the source and modeling parameters used for this assessment.

Table 1: Dispersion Modeling Parameters

Source Type	area
Dispersion Setting	urban
Receptor Height	1.5 meters
Initial Vertical Dispersion Parameter (s_z)	2.5 meters
Area Source Width	16.8 meters
Area Source Length	218.8 meters
PM Emission Factor	0.7 grams/hp-hr
Day (7 AM to 7 PM) Plume Height	4.46 meters
Night (7 PM to 7 AM) Plume Height	12.79 meters

C. Health Risk Assessment Methods

Maximum offsite concentrations were used to estimate potential cancer risk due to emissions of diesel PM. The maximum offsite ambient annual concentration, in micrograms per cubic meter ($\mu g/m^3$), is applied to the unit risk factor (URF) developed for diesel PM by OEHHA. This URF is 300 excess cancers per million people per $\mu g/m^3$ of exposure to diesel PM and assumes a residential exposure of 70 years. Other exposure parameters in OEHHA risk assessment guidelines (OEHHA, 2000 and OEHHA, 2003), including the revised breathing rate and cancer potency factor, are reflected in the assessment results.

Table 2 through Table 6 present the estimated range of potential cancer health risks at nearby receptor locations due to exposures to five diesel TRU PM emission rates (0.7, 1.0, 0.3, 0.22, and 0. 2 g/hp-hr) from a large area source. The cancer health risks are shown based on hours of diesel TRU operation and downwind distance of the receptor. The horizontal line shaded boxes show where potential cancer risks are greater than or equal to (=) 100 per million. The grey shaded boxes show where potential cancer risks are less than (<) 10 per million. The unshaded boxes show where the potential cancer risk is = 10 and < 100 per million.

Table 2 Estimated Range of Potential Cancer Health Risks (per million) due to TRUs Operating at a Large Distribution Area Source – 0.7 g/bhp-hr

Total Hours of TRU Engine Operation		Downwind Distance (m) from Center of Area Source											
Per Week	Per Year	100	150	200	250	300	350	400	450	500	600	700	800
100	5,200												
150	7,800												
200	10,400												
250	13,000												
300	15,600												
350	18,200												
400	20,800												
450	23,400												
500	26,000												
600	31,200												
700	36,400												
800	41,600												
900	46,800												
1,000	52,000												
1,100	57,200												
1,200	62,400												
1,300	67,600												
1,400	72,800												
1,500	78,000												

Meteorological Data: West LA (1981)
Emission Parameters: Engine Size - 35 hp, Engine Load Factor - 60%, Area Source.
Grey Shading shows Cancer Risks < 10/million
No Shading shows Cancer Risks = 10/million and < 100/million
Horizontal Line Shading shows Cancer Risks = 100/million
Annual emissions assume 52 weeks of operation

Table 3 Estimated Range of Potential Cancer Health Risks (per million) due to TRUs Operating at a Large Distribution Area Source – 1.0 g/bhp-hr

Total Hours of TRU Engine Operation		Downwind Distance (m) from Center of Area Source											
Per Week	Per Year	100	150	200	250	300	350	400	450	500	600	700	800
100	5,200												
150	7,800												
200	10,400												
250	13,000												
300	15,600												
350	18,200												
400	20,800												
450	23,400												
500	26,000												
600	31,200												
700	36,400												
800	41,600												
900	46,800												
1,000	52,000												
1,100	57,200												
1,200	62,400												
1,300	67,600												
1,400	72,800												
1,500	78,000												

Meteorological Data: West LA (1981)

Emission Parameters: Engine Size - 35 hp, Engine Load Factor - 60%, Area Source.

Grey Shading shows Cancer Risks < 10/million

No Shading shows Cancer Risks = 10/million and < 100/million

Horizontal Line Shading shows Cancer Risks = 100/million

Annual emissions assume 52 weeks of operation

Table 4 Estimated Range of Potential Cancer Health Risks (per million) due to TRUs Operating at a Large Distribution Area Source – 0.3 g/bhp-hr

Total Hours of TRU Engine Operation		Downwind Distance (m) from Center of Area Source											
Per Week	Per Year	100	150	200	250	300	350	400	450	500	600	700	800
100	5,200												
150	7,800												
200	10,400												
250	13,000												
300	15,600												
350	18,200												
400	20,800												
450	23,400												
500	26,000												
600	31,200												
700	36,400												
800	41,600												
900	46,800												
1,000	52,000												
1,100	57,200												
1,200	62,400												
1,300	67,600												
1,400	72,800												
1,500	78,000												

Meteorological Data: West LA (1981)

Emission Parameters: Engine Size - 35 hp, Engine Load Factor - 60%, Area Source.

Grey Shading shows Cancer Risks < 10/million

No Shading shows Cancer Risks = 10/million and < 100/million

Horizontal Line Shading shows Cancer Risks = 100/million

Annual emissions assume 52 weeks of operation

Table 5 Estimated Range of Potential Cancer Health Risks (per million) due to TRUs Operating at a Large Distribution Area Source – 0.22 g/bhp-hr

Total Hours of TRU Engine Operation		Downwind Distance (m) from Center of Area Source											
Per Week	Per Year	100	150	200	250	300	350	400	450	500	600	700	800
100	5,200												
150	7,800												
200	10,400												
250	13,000												
300	15,600												
350	18,200												
400	20,800												
450	23,400												
500	26,000												
600	31,200												
700	36,400												
800	41,600												
900	46,800												
1,000	52,000												
1,100	57,200												
1,200	62,400												
1,300	67,600												
1,400	72,800												
1,500	78,000												

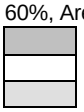
Meteorological Data: West LA (1981)

Emission Parameters: Engine Size - 35 hp, Engine Load Factor - 60%, Area Source.

Grey Shading shows Cancer Risks < 10/million

No Shading shows Cancer Risks = 10/million and < 100/million

Horizontal Line Shading shows Cancer Risks = 100/million



Annual emissions assume 52 weeks of operation

Table 6 Estimated Range of Potential Cancer Health Risks (per million) due to TRUs Operating at a Large Distribution Area Source – 0.02 g/bhp-hr

Total Hours of TRU Engine Operation		Downwind Distance (m) from Center of Area Source											
Per Week	Per Year	100	150	200	250	300	350	400	450	500	600	700	800
100	5,200												
150	7,800												
200	10,400												
250	13,000												
300	15,600												
350	18,200												
400	20,800												
450	23,400												
500	26,000												
600	31,200												
700	36,400												
800	41,600												
900	46,800												
1,000	52,000												
1,100	57,200												
1,200	62,400												
1,300	67,600												
1,400	72,800												
1,500	78,000												

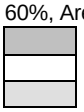
Meteorological Data: West LA (1981)

Emission Parameters: Engine Size - 35 hp, Engine Load Factor - 60%, Area Source.

Grey Shading shows Cancer Risks < 10/million

No Shading shows Cancer Risks = 10/million and < 100/million

Horizontal Line Shading shows Cancer Risks = 100/million



Annual emissions assume 52 weeks of operation

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OEHHA, 2000. Office of Environmental Health Hazard Assessment (OEHHA), *Air Toxics "Hot Spots" Program Risk Assessment Guidelines Part IV Technical Support Document for Exposure Assessment and Stochastic Analysis.* www.oehha.ca.gov/air/hot_spots/finalStoc.html. September 2000.

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