Appendix
LAX Master Plan Final EIS

A-2b. Summary Comparison of Hazardous Air Pollutant Emissions and Dispersion Using the FAA EDMS and EPA ISCST3 Models

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1. INTRODUCTION

The emission and dispersion analyses of hazardous air pollutants (HAPs, also referred to as toxic air pollutants or TAPs) conducted for Alternatives A, B, C, and D, and the No Action/No Project Alternative are presented in the LAX Master Plan Final Environmental Impact Statement (Final EIS), Section 4.24.1, *Human Health Risk Assessment,* Technical Report 14a, *Human Health Risk Assessment Technical Report*, and Technical Report S-9a, *Supplemental Human Health Risk Assessment Technical Report*. These analyses followed the Air Quality Modeling Protocol for Toxic Air Pollutants presented in Technical Report 14a, Attachment F. The emission and dispersion of volatile organic compound (VOC) and inhalable particulate matter (PM_{10}), which form the basis of the HAP analysis, followed the Air Quality Modeling Protocol for Criteria Air Pollutants presented in Technical Report 4, Attachment A. At the time these protocols were originally developed, the FAA's airport air quality model, EDMS, did not have the capability of assessing VOC concentrations. Therefore, all dispersion modeling of HAPs from LAX sources was conducted using the U.S. Environmental Protection Agency's (USEPA) ISCST3 model to calculate concentrations.

Since publication of the Draft EIS/EIR in January 2001, EDMS has been enhanced several times. One of the enhancements (EDMS 4.11) includes the ability to model hydrocarbon (HC) or VOC concentrations, using USEPA's AERMOD air dispersion model. This report compares the HAP analysis concentrations used in the Final EIS health risk assessment with those that would have been estimated if EDMS 4.11 had been used to estimate concentrations. This comparison is made to determine whether the reported risks in the Final EIS are more or less conservative than those that would have been reported using EDMS 4.11, and by what order of magnitude the difference might be.

2. EMISSION ESTIMATES

Emissions of HAPs associated with VOCs and PM_{10} emitted by various sources at LAX were calculated using VOC and PM_{10} emissions and source speciation profiles, which are comprised of species and their weight fractions either based on VOC or PM_{10}. The speciation profiles vary by source type: aircraft, ground support equipment (GSE), auxiliary power units (APU), on-road vehicles, parking lots, and stationary sources on LAX. The speciation profiles for LAX were either developed from existing test data or obtained from the California Air Resources Board (CARB) speciation profile database. Similar to other criteria pollutants, the VOC/PM_{10} emissions were modeled using EDMS for aircraft, APU and GSE, and CARB's EMFAC emission model for on-road vehicles. Since PM_{10} emission factors from aircraft are not readily available, the elemental metal HAP emissions were estimated using emission factors for stationary source combustion turbines using distillate fuel from the California Toxic Emission Factors (CATEF) database (specific factors were included in the tables to Technical Report 4, Attachment C).

For the Draft EIS/EIR, HAP emissions from aircraft, APUs, and GSE for Alternatives A, B, and C, and the No Action/No Project Alternative, as well as the 1996 Environmental Baseline were originally developed using EDMS Version 3.22 (EDMS 3.22). On-road source emissions for these scenarios were originally developed using CARB's EMFAC2000 model. These were the models that were available when the analysis of Alternatives A, B, and C was initiated.

The analysis of Alternative D began approximately two years later, and the models previous used had been updated. Therefore, Alternative D HAP emissions from aircraft, APUs, and GSE were developed using both EDMS 4.11 and EDMS 3.22, and on-road vehicle emissions were developed using EMFAC2002. These models were released for use prior to the start of the Alternative D air quality impact analysis and included a number of enhancements and improvements (including updated emission factors), and thus were considered more accurate for developing HAP emissions. The 1996 Environmental Baseline was recalculated with EDMS 4.11 and EMFAC2002. The ratio of EDMS 4.11 to EDMS 3.22 emissions for each HAP was determined from the Alternative D estimates. These ratios were then applied to the HAP emissions for Alternatives A, B, and C, and the No Action/No Project Alternative to correct the original values to those consistent with the updated models.

The most significant difference between the original analysis and the analysis of Alternative D was the change in GSE HC emissions. It was later determined that a revised version of USEPA's NONROAD Model was used in developing GSE HC emission factors for use in EDMS 4.11. These factors had much higher HC values for natural gas-fueled GSE than the previous version. Since LAX has a considerable fraction of alternative fueled GSE including natural gas equipment, the HC emissions were much higher than the original analysis indicated. However, much of the HC emission is in the form of methane, a non-regulated, non-HAP compound. Thus the supplemental analysis for Alternative D published in July 2003 overestimated the HC-based HAP emissions. Prior to completing the Final EIR in April 2004, the CARB OFFROAD emission model was used to develop emission factors for GSE for all fuel types.

In conducting the original analysis, and the analysis for Alternative D, emissions of diesel particulate matter (diesel PM) were assumed to be equal to all particulate matter emitted from GSE and on-airport motor vehicle exhaust. This assumption is conservative since it assumes that all exhaust PM comes from diesel engines although a large percentage of equipment and vehicles run on gasoline or alternative fuels.

For the analysis conducted using EDMS/AERMOD, the HAP emissions from aircraft and APUs were based on HC emission indices contained in EDMS 4.11 and elemental HAP emission factors from a study of Jet A fuel composition (Shumway 2000). The GSE emissions are based on the CARB OFFROAD model, which includes engine deterioration factors. In addition, final model runs used PM_{10} from diesel engines only to calculate diesel PM emissions. On-road vehicle emissions were based on EMFAC2002. The HAP speciation profiles used for LAX sources are presented in **Table 1**, LAX Airport Operation HAP Speciation Profiles.

Table 1

LAX Airport Operation HAP Speciation Profiles

	Roadway lb/lb TOG	Parking lb/lb TOG	Stationary lb/lb HC	GSE lb/lb HC	Taxi lb/lb HC	Takeoff lb/lb HC	Climbout lb/lb HC	Approach lb/lb HC
Acetaldehyde	2.30E-03	2.30E-03	1.16E-03	6.12E-03	2.49E-02	2.21E-02	3.22E-02	4.17E-02
Acrolein	1.30E-03	1.30E-03	3.67E-04	1.42E-03	1.21E-02	7.24E-03	6.76E-03	9.36E-03
Benzene	2.50E-02	2.50E-02	7.71E-03	4.11E-02	1.76E-02	7.44E-03	2.38E-02	2.35E-02
1,3-Butadiene	5.20E-03	5.20E-03	4.00E-04	7.86E-03	1.57E-02	8.42E-03	7.72E-03	9.69E-03
Formaldehyde	1.62E-02	1.62E-02	1.24E-02	1.00E-02	8.17E-02	4.14E-02	1.03E-01	1.24E-01
Toluene	5.59E-02	5.59E-02	5.77E-03	8.05E-02	2.57E-02	5.46E-03	6.79E-03	1.55E-02
Xylene (total)	4.66E-02	4.66E-02	4.46E-03	8.31E-02	1.87E-02	6.60E-03	7.87E-03	1.56E-02
Naphthalene	5.00E-04	5.00E-04	1.08E-03	1.31E-03	1.51E-02	1.49E-03	4.39E-03	2.64E-02
PAH	2.02E-06	1.02E-06	2.49E-05	3.21E-06	7.16E-06	4.11E-05	6.78E-05	2.86E-05
TCDD	1.66E-09	1.83E-09	7.81E-12	1.36E-09	1.23E-09	4.93E-08	5.20E-08	1.53E-08
Arsenic	3.28E-06	1.72E-06	1.02E-05	6.49E-07	6.57E-06	2.64E-04	2.78E-04	8.17E-05
Beryllium	0.00E+00	0.00E+00	3.06E-07	5.34E-08	1.77E-06	7.10E-05	7.47E-05	2.20E-05
Cadmium	7.57E-07	3.97E-07	1.04E-04	3.92E-06	1.06E-05	4.25E-04	4.47E-04	1.31E-04
Chromium (hex)	1.27E-06	5.32E-07	1.65E-07	1.06E-08	3.51E-07	1.41E-05	1.49E-05	4.37E-06
Copper	3.58E-05	1.84E-05	4.33E-05	5.15E-06	3.25E-05	1.30E-03	1.37E-03	4.04E-04
Manganese	1.70E-04	9.14E-05	2.14E-05	1.57E-05	3.35E-04	1.35E-02	1.42E-02	4.17E-03
Nickel	7.84E-06	3.17E-06	1.13E-04	5.17E-05	1.59E-03	6.38E-02	6.71E-02	1.97E-02
Zinc	2.09E-04	1.13E-04	1.64E-04	9.43E-05	1.75E-03	7.03E-02	7.40E-02	2.18E-02
Diesel PM	1.13E-02	2.34E-03	0.00E+00	9.00E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Source: CDM 2004.

3. AIR DISPERSION MODELING

Air dispersion modeling was used to estimate ambient HAP concentrations for the operational scenarios. The analyses conducted for the Final EIS utilized the ISCST3 model. The analysis conducted for this report used the AERMOD model that is incorporated into EDMS 4.11. Below are brief descriptions of how each model was used.

3.1 ISCST3

3.1.1 Aircraft

Aircraft were modeled as series of one-dimensional point sources, distributed in equal emission increments for each of the engine modes (Taxi/Idle, Approach, Climbout, Takeoff) and each of three aircraft engine sizes. Use of point sources allowed the model to include plume rise from the hot engine exhaust. The three aircraft sizes are defined as Small, Medium, and Large. The aircraft size cutoff points are based on both airframe and engine size, as shown in **Table 2**, Assigned Aircraft Size. The buoyant plume rise of turbofan and turboprop engine exhaust was taken into account in the plume rise algorithms. Plume rise is proportional to the heat released in the exhaust; therefore, grouping similar engine sizes more accurately estimates plume rise from various aircraft located around the airport than averaging all aircraft. Additionally, these grouped engine sizes and types (turbofan vs. turboprop) have different emission properties (lb emissions/lb fuel) which are more accurately modeled in the different size groups than averaged over all aircraft.

Table 2

Assigned Aircraft Size

Size	Aircraft	Engine Model No.	No. of Engines	Heat Rate* per engine (MMBtu/hr)
Small	ATR42	PW121	2	12.86
	ATR72-200	PW124-B	2	14.25
	BAE146-300	ALF502R-5	4	34.00
	BH-1900	PT6A-65B	2	7.40
	Canadair RJ50	CF34-3A1	2	38.64
	Candair RJ70	CF34-3A1	2	38.64
	DASH-7	PT6A-50	4	7.84
	EMB110KQ1	PT6A-27	2	5.08
	EMB-120	PW118	2	11.29
	FOKKER 50	PW125-B	2	14.54
	GenAvJet	JT15D-1	2	14.05
	GenAvProp	PT6A-67B	1	8.34
	Jetstream 31	TPE331-3	2	5.49
	Saab 2000	AE2100A	2	21.64
	SF-340A	CT7-5	2	9.59
	SHORT 360	PT6A-65AR	2	8.41
	Swearingen Metro 2	TPE331-3	2	5.49
Medium	A319	CFM56-5A1	2	99.78
	A320	CFM56-5B4	2	110.70
	B727-200	JT8D-15	3	111.84
	B737-200	JT8D-9A	2	98.74
	B737-300/400/500	CFM56-3C	2	82.79
	B737 Cargo	JT8D-17A	2	111.36
	B757-200	PW2037	2	146.02
	DC9-50	JT8D-17	2	118.20
	F-28-4000	RR SPEY-MK555	2	69.78
	FOKKER 70	TAY620-15	2	72.15
	FOKKER 100-100	TAY 650-15	2	82.98
	MD-80	JT8D-217A	2	125.32
	MD-80-87	JT8D-217	2	125.32
	MD-90-10	V2525-D5	2	99.97
	MD-90-95	BR700-710A1-10	2	67.12
Large	A300B	CF6-50C	2	225.86
	A300-C4-200 Cargo	CF6-50C2	2	236.11
	A310-200	CF6-80C2A2	2	200.98
	A330	CF6-80E1A1	2	256.52

Table 2

Assigned Aircraft Size

Size	Aircraft	Engine Model No.	No. of Engines	Heat Rate* per engine (MMBtu/hr)
	A340-200	CFM56-5C2	4	124.18
	B747-200	JT9D-7R4G2	4	230.61
	B747-400/Combo/X	PW4056	4	222.35
	B767	JT9D-7R4D	2	195.10
	B777	PW4084	2	323.84
	DC8-70	CFM56-2C5	4	93.51
	DC10-30	CF6-50C2	3	236.11
	IL-96	PS-90A	4	165.10
	L1011-500	RB211-524B4	3	209.81
	MD-11	PW4460	3	251.30

Source: CDM, Air Quality Modeling Protocol for Criteria Pollutants, 2001.

3.1.2 Ground Support Equipment (GSE)/Auxiliary Power Units (APU)

GSE emissions actually occur over a broad area of the airport. The emissions calculated for many of the units occur as the unit travels from a support facility to the gate being serviced. However, for simplification and conservatism, the emissions are grouped into area sources around separate gate areas. The GSE and APUs are assumed to operate near or on the aircraft while it is parked at a gate. The width of the GSE/APU source areas is 30 meters, starting 5 meters from the edge of the terminal/structure and extending back towards the tail of the aircraft. The length of the source area is defined as the length of each specific gate area. Specific maximum hourly emissions and temporal curves are used for each of these gate areas through analysis of the SIMMOD arrival and departure data.

3.1.3 On-Airport Motor Vehicles

The traffic maximum hourly emissions are based on the maximum traffic volume projections for each alternative. The emissions are calculated based on the defined fleet mix using EMFAC2002. The estimated idle emissions are included in the emission estimates of the terminal areas. The emissions calculated for each defined roadway segment are divided evenly between the number of volume sources that comprise that segment, and temporal files that have been calculated for the east and west terminal traffic are applied to each of the volume sources.

The emissions from parking structures are modeled as volume sources for the environmental baseline, the No Action/No Project Alternative, and Alternatives A, B and C, and as area sources for Alternative D.[1] Most of the parking lots included in Alternatives A, B, and C are multi-level parking garages, while many of the parking areas included in Alternative D are single level surface lots. Therefore, the three-dimensional garages were modeled as volume sources while the two-dimensional surface lots were modeled as area sources. Each parking structure/area is broken up into squares or rectangles that define the specific area to be modeled by each volume source. Some of the parking areas are nearly square and can be modeled using one volume source, while complex shaped parking garages/areas are divided into several equivalent volume sources.

The maximum hourly emissions for each parking area are calculated based on the estimated maximum parking projections and the emissions are calculated based on the project defined fleet mix and project defined average vehicle speed using EMFAC2002. The idle emissions for each parking area are included in the emission estimates.

1 In air quality modeling, volume sources are those with emissions that are initially spread out over three-dimensional space, while area sources are those with emissions that are initially spread out in only two dimensions.

3.1.4 Stationary Sources

Dispersion modeling of the stationary source emissions was performed based on the project source configurations and the source types found during the environmental baseline survey. Conservatively, and for simplification of dispersion modeling, emissions were combined into a single source (e.g., maintenance, flight kitchens, restaurants) for smaller source types found at single source facilities. Source locations were determined from a review of the proposed airport layout plans for each alternative. Typical stack dimensions and heights were used for the specific source types and these stacks were then compared to assumed building heights at each stationary source location to assure engineering consistency of their relative heights.

3.2 EDMS 4.11 with AERMOD

3.2.1 Aircraft

Aircraft were modeled as area sources, using the EDMS 4.11 input file for AERMOD.

3.2.2 Ground Support Equipment (GSE)/Auxiliary Power Units (APU)

GSE and APU emissions were modeled as volume sources at each terminal, using the EDMS 4.11 input file for AERMOD. Three-dimensional volume sources are typically used to model pollutants emitted from multiple locations in a small region. The various GSE servicing one or more aircraft tend to be spread around the terminal gates horizontally (nose to tail and wing tip to wing tip), with APUs located vertically above the ground. Thus, the combination of GSE and APU at the gates tends to create three-dimensional (volume) sources.

3.2.3 On-Airport Motor Vehicles

Traffic emissions were modeled as area sources over the roadways and parking lots, using the EDMS 4.11 input file for AERMOD.

3.2.4 Stationary Sources

Dispersion modeling of the stationary source emissions was performed based on the project source configurations and the source types found during the environmental baseline survey. Conservatively, and for simplification of dispersion modeling, emissions were combined into a single source (e.g., maintenance, flight kitchens, restaurants) for smaller source types found at single source facilities. Source locations were determined from a review of the proposed airport layout plans for each alternative. Typical stack dimensions and heights were used for the specific source types and these stacks were then compared to assumed building heights at each stationary source location to assure engineering consistency of their relative heights.

3.3 Meteorological Data

The 12-month period of hourly meteorological data from LAX were used to create the input meteorological data files for both ISCST3 and EDMS/AERMOD dispersion modeling. The SCAQMD has indicated that upper air data (mixing heights) recently collected at LAX should be used in the dispersion models (SCAQMD 1998c). Therefore, the meteorological data file consists of hourly surface and upper air data from the LAX meteorological observation station for the 12-month period beginning March 1, 1996 and ending February 28, 1997 (SCAQMD 1998d). The surface data set consists of hourly values of wind speed, wind direction, surface air temperature, and atmospheric stability. The upper air data consists of hourly mixing heights. This data set represents the most recent set of complete (surface and upper air) data collected at LAX.

3.4 Temporal Files

For the ISCST3 analyses, hour of day temporal files were developed as modeling input for all sources, which is considered the best approximation method for modeling the emissions that occur at the airport.

Most airport operations/emissions peak around noon or the early afternoon with other sub-peaks occurring during the morning, afternoon and evening hours. Between midnight and six a.m. there are very few aircraft operations and low overall emissions for associated activities (i.e., GSE, traffic, parking). Temporal files for aircraft and GSE activities are calculated using the SIMMOD model data for each project alternative horizon year. The traffic consultants provided temporal files for roadways and parking for the west side and east side of the airport. Temporal files were used to match emissions with the meteorological conditions that occur during each hour of the day.

For EDMS/AERMOD, hour-of-day, day-of-week, and month-of-year temporal files were used. The same temporal files used to estimate emissions from EDMS 4.11 were included in the dispersion analysis.

3.5 Chemical Concentrations

In summary, a two-step process was used to estimate the off-site ambient air concentrations of HAPs. First, total VOC emission rates estimated for aircraft sources, ground access sources, and GSE/APU sources (as discussed in Section 2.0) were multiplied by the chemical-specific weight fraction from the appropriate source speciation profile to estimate chemical-specific emission rates for each HAP. Second, the annual average concentration-to-emission ratios (X/Q's) at the receptors of concern were obtained from the air dispersion analysis as discussed above. Third, these X /Q factors were multiplied by the chemical specific emission rates determined in the first step to obtain chemical specific air concentrations at the receptors of concern from airport emissions for each scenario. The incremental HAP concentration analysis evaluated HAP concentrations for the horizon year of the build alternatives minus the 1996 baseline results.

4. COMPARISON BETWEEN ISCST3 AND AERMOD MODELING RESULTS

Alternative D has been modeled using ISCST3, as described in the EIS/EIR protocols, and by AERMOD, which was incorporated in EDMS 4.11 – the model required by FAA for airport emission and dispersion calculations. Different source types and parameters were used in the two models. As shown in **Table 3**, Comparison of Source Types, EDMS/AERMOD modeled aircraft and roadway sources as area sources, and GSE/APU as volume sources, while the ISCST3 modeled the aircraft sources as point sources, roadways as volume sources, GSE/APU as area sources.

The results were analyzed by creating a ratio between ground-level concentrations at each location from different modeling results, similar to the HC ratios shown in **Figure 1,** Concentration Ratio of AERMOD/ISCST3 for Alternative D Unmitigated. The ratio varied in a relatively broad range between 0 and 5, which could be attributed to the combined effects of the different source types and different dispersion mechanism. However, the HC peak concentrations, which were used to determine the health risks, are not substantially different, with an ISCST3 result of 29.0 $\mu g/m^3$ compared to the AERMOD result of 33.9 $\mu g/m^3$.

Figure 1 Concentration Ratio of AERMOD/ISCST3 for Alternative D Unmitigated

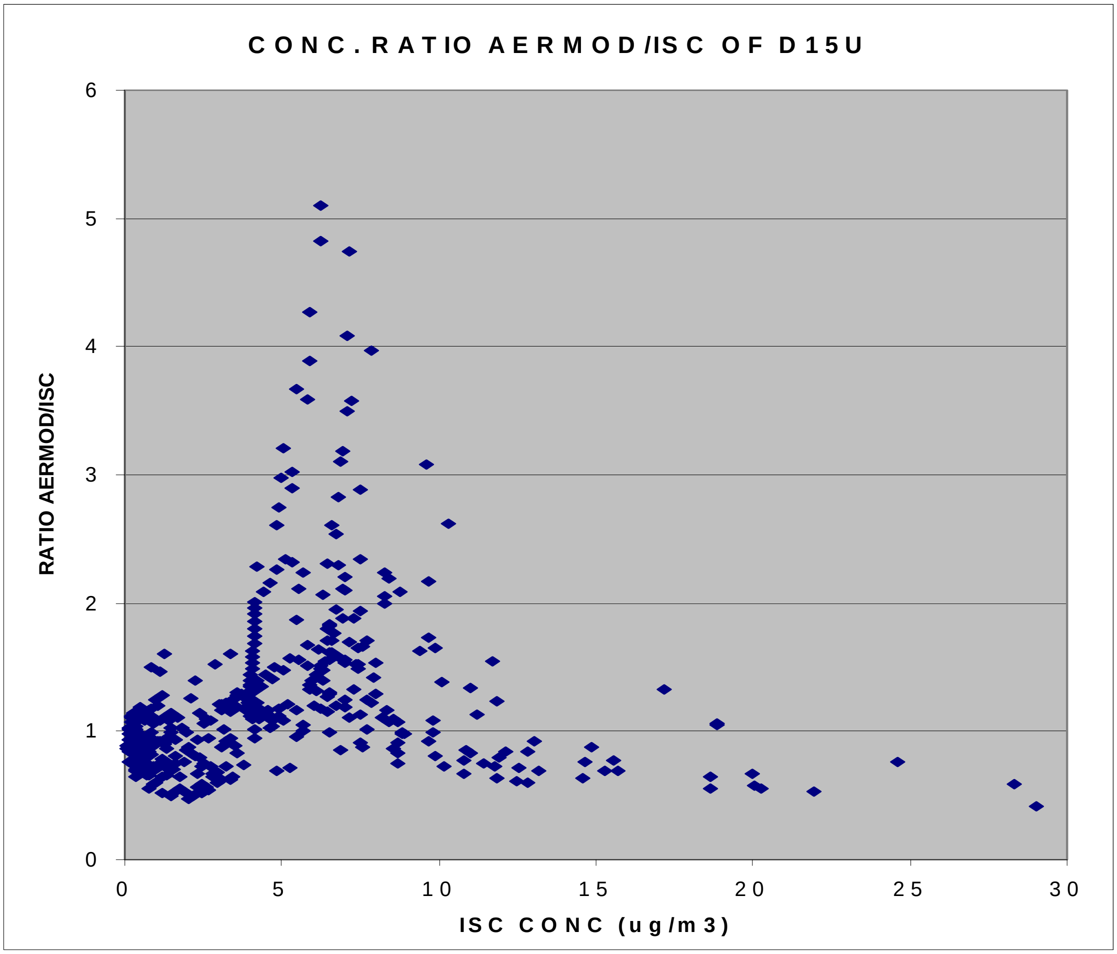

Table 3

Comparison of Source Types

Source	EDMS/AERMOD	ISCST3
Aircraft	AREA	POINT
GSE/APU	VOLUME	AREA
Roadways	AREA	VOLUME
Parking Lots	AREA	AREA (Alt D only)
Stationary	POINT	POINT

Source: CDM 2004.

According to the South Coast Air Quality Management District's (SCAQMD) MATES II report (published in November 1999), a study on regional health risks, diesel PM is the major contributor to cancer risks. As shown in **Table 4**, 1998 Key Toxic Air Contaminants and their Contribution to the Ambient Cancer Risk (%), the MATES II report indicated that about 72 percent of regional cancer risks are attributed by MATES to diesel PM related emissions. Therefore, diesel PM emissions and impacts were given more emphasis in this analysis. Unlike other alternatives, diesel PM in Alternative D was modeled directly by EDMS/AERMOD, instead of using speciation profiles from VOC and PM because the new version of EDMS 4.11 allows input of diesel emission factors and generation of AERMOD input file for diesel PM. Since this method reduced the errors and uncertainties from the conversion of VOC/PM_{10} to diesel PM using different source speciation profiles, it is believed that the modeling provided more accurate ground-level diesel PM concentrations. The EDMS 4.11 modeling results showed lower ground concentrations of diesel PM than the results using the ISCST3 modeling VOC/PM_{10} and speciation profiles. The diesel PM peak concentrations are 0.27 µg/ m^3 using AERMOD, and 0.86 µg/m^3 using ISCST3. The corresponding incremental concentrations relative to the 1996 baseline are presented in **Table 5,** Comparison of Diesel PM Peak Incremental Concentrations Modeled by ISCST3 and EDMS/AERMOD for Alternative D.

Table 4

1998 Key Toxic Air Contaminants and their Contribution to the Ambient Cancer Risk (%)

TACs	Risk Contribution (%)[1]
Diesel PM	72.0
1,3-butadiene	8.4
Benzene	6.5
Formaldehyde	2.0
Hexavalent chromium	1.8
Perchloroethylene	0.8
Para-Dichlorobenzene	0.7
Acetaldehyde	0.6
Methylene chloride	0.2
Nickel	0.2
Trichloroethylene	0.1

[1] Based on the average of the pollutant concentrations measured at the fixed monitoring sites.

Source: SCAQMD, MATES II, November 1999.

Table 5

Comparison of Diesel PM Peak Incremental Concentrations Modeled by ISCST3 and EDMS/AERMOD for Alternative D

	Peak Conc. Increment	X	Y	Location
ISC	0.046	2000	-1000	Off-site workers-proposed surface parking area
ISC	0.009	3435	-1119	Resident
AERMOD	0.033	2295	-275	Off-site workers-proposed surface parking area
AERMOD	-0.011	3435	-1119	Resident

Source: CDM 2004.

5. CONCLUSIONS

In conclusion, the health risk assessment presented in the Final EIS represents a conservative (high) estimate of actual health risks from hazardous air pollutants. The more refined modeling available with EDMS 4.11 (using AERMOD algorithms) indicates that the peak reported concentrations of diesel PM are less than those reported in the Final EIS. Therefore, using the refined EDMS 4.11 model results would only lower the airport's incremental risk estimates.