South Coast
Air Quality Management District
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Health Risk Assessment Guidance for Analyzing Cancer Risks from Mobile Source Diesel Idling Emissions for CEQA Air Quality Analysis

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Introduction

In 1998, following an exhaustive 10-year scientific assessment process, the State of California Air Resources Board (ARB) identified particulate matter from diesel-fueled engines as a toxic air contaminant.[1] Subsequent to this determination, the South Coast Air Quality Management District (SCAQMD) initiated a comprehensive urban toxic air pollution study, called MATES-II (for Multiple Air Toxics Exposure Study).[2] MATES-II showed that average cancer risk in the South Coast Air Basin (Basin) ranges from 1,100 in a million to 1,750 in a million, with an average regional risk of about 1,400 in a million. More over, diesel particulate matter (DPM) accounts for more than 70 percent of the cancer risk.

Over the last several years, areas in the eastern portion of the Basin have undergone significant land-use transformation. Agriculture land has been converted into truck stops and warehouse distribution centers. The air pollution impacts from such development are dominated by the carcinogenic risk of the DPM emissions. The Governing Board Mobile Source Committee directed the AQMD staff to assess the health risks from truck stops and warehouse distribution centers. Based on this analysis, a prior version of this document (dated December 2002) was prepared to provide technical guidance to interested parties (i.e., our recommended procedures for preparing CEQA documents for applicable projects with mobile source diesel emissions). Later, staff also developed technical guidance for addressing potential DPM impacts from the following activities: truck idling and movement, ship hotelling and train idling. This document which constitutes the technical guidance report was reviewed by the Mobile Source Committee of the Board.

It should be noted that CARB staff intends to issue statewide technical guidance for diesel toxic impact analyses for various source categories. Until such time, this document will serve as an interim technical guidance for estimating potential DPM impacts from the following activities:

- Truck idling and movement (such as, but not limited to, truck stops, warehouse/distribution centers or transit centers),
- Ship hotelling at ports, and
- Train idling.

AQMD staff is also available to work with project proponents to address unique project-specific applications.

The remainder of the document provides guidance on the following components of a typical DPM risk analysis: project description, project emissions, dispersion modeling, estimation of health risks, and lastly, potential mitigation measures.

Project Description

The modeling analysis should contain a brief description of the facility and its activities. Table 1 lists the information on the facility and its surroundings that must be provided in the modeling analysis. The facility location is used to determine the most representative meteorological data for the analysis. The nearby land use and topography information is needed to choose the appropriate model and its options (e.g., urban versus rural, simple terrain versus complex terrain) and to determine applicable exposure adjustments (e.g. residential or worker exposure). It should be noted that it is SCAQMD procedure to assume an urban setting for facilities in the Basin. Justification should be provided if the rural classification is used.

Table 1. Required Source Information.

<u>Information on the Facility and Its Surroundings</u>

- Location (i.e., address)
- Local land use (within 20 km)
- Local topography (within 20 km)
- Facility plot plan
  - Property line
  - Horizontal scale
  - Building height (for building downwash calculations if necessary)
  - Source locations
- Operating schedule (i.e., hours/day, days/week, weeks/year)

<u>Point Source Information (i.e., Stationary Sources Associated with the Project)</u>

- Hourly emission rate
- Annual emissions
- Stack location on plot plan (UTM coordinates)
- Stack height
- Stack diameter
- Stack gas exit velocity
- Stack gas exit temperature
- Building dimensions and location if applicable

<u>Fugitive Source or Mobile Source Information</u>

- Hourly emission rate
- Annual emissions
- Source location on plot plan (UTM coordinates)
- Source height
- Area or volume dimension

The facility plot plan (including a length scale) is needed to determine the source location, building dimensions, and the property boundary or right-of-way boundary. The operating schedule (i.e., hours/day, days/week, weeks/year, etc.), the hourly DPM emission rate, the annual DPM emissions, and the source parameters listed in the Table 1 are necessary to accurately characterize the source emission rate for modeling. One should keep in mind that the more information provided on the facility operating schedule the more appropriately the facility can be modeled. The same applies to the characteristics of the source, such as the release height of the emissions.

Table 2. Information Necessary to Calculate Diesel Particulate Emissions from Truck Idling and Movement.

Truck Traffic on Local Streets and/or Arterials

- Number of trucks visiting the facility per day
- Composite DPM emission factor (in grams per mile) based on project year and average vehicle speed
- Travel distance on the local streets and/or arterials (in miles)

On-Site Truck Movement

- Number of trucks visiting the facility per day
- On-site travel distance (in miles)
- Composite DPM emission factor (in grams per mile) based on project year and vehicle speed

On-Site Truck Idling

- Number of trucks visiting the facility per day
- Average idling time per truck
- Composite idling emission factor (grams per minute) based on project year

Transportation Refrigeration Units (TRUs)

- Number of TRUs operating per hour
- Operating time per hour (in minutes per hour)
- TRU emission factor (in grams per minute) based on horsepower rating and load factor

Auxiliary Power Units (APUs)

- Number of APUs operating per hour
- Operating time per hour (in minutes per hour)
- APU emission factor (in grams per minute) based on horsepower rating and load factor

Project Emissions

Truck Idling and Movement

Emissions of diesel particulates can occur from the following activities associated with diesel trucks:

- Truck traffic on local streets and arterials in transit to or from the facility (i.e., truck stop, warehouse/distribution center or transit center),
- Truck idling and movement on-site at the facility (i.e., truck stop, warehouse/distribution center or transit center), and
- Operation of Transportation Refrigeration Units (TRUs) at the facility (i.e., truck stop, warehouse/distribution center or transit center).

Table 2 summarizes the information required to estimate DPM emissions from the facility. The latest version of EMFAC[3] should be used to estimate the composite DPM emission factor for truck movement on local streets and truck movement and idling on the proposed facility property. EMFAC is ARB's computer model to estimate past, present, and future on-road emissions of HC, CO, NO_X, PM, lead, SO_2, and CO_2. Make sure EMFAC is run for a calendar year and county/air basin representative of the proposed project. From the output, select the DPM emission factor for the vehicle class and speed pertinent to the proposed project.

DPM emission factors for transportation refrigeration units (TRUs) can be obtained from an appendix in ARB's risk reduction plan for diesel particulate emissions.[4]

Ship Hotelling at Local Ports

Emissions of DPM from ships are mainly concentrated in the San Pedro Bay Ports (SPBP) which includes the Port of Los Angeles and the Port of Long Beach. Ships that contribute to DPM emissions in the SPBP are oceangoing vessels, tugboats, fishing vessels, U.S. Navy vessels, U.S. Coast Guard vessels, and other harbor vessels such as work boats, pilot boats, and passenger cruise boats. Most DPM emissions, however, are generated by oceangoing vessels. DPM emissions vary depending on a ship's mode of activity. Ships are on cruise mode when they enter or leave the South Coast waters which are approximately 100 miles from the coastline. While in Port, ships are either on "hotelling and berthing" mode or on maneuvering mode when ships move from one berth to another. The ships' power requirements during hotelling or berthing are supplied by continuously operating its diesel-fueled auxiliary engines and boilers. The latest update on DPM emissions in the SPBP can be found in the report entitled, *Marine Vessels Emissions Inventory Update to 1996 Report: Marine Vessel Emissions Inventory and Control Strategies.*[5]

Table 3. Information Necessary to Calculate Diesel Particulate Emissions from Ship Hotelling at Local Ports.

Hotelling Operations
▪ Number of ships
▪ Average hotelling hours for each ship type
▪ Auxiliary power engine emission factor for particulate matter, lbs/hr

Table 3 summarizes the information required to estimate DPM emissions from the shipping activities in the local ports.

Train Idling

Emissions of diesel particulate matter from train idling occurs predominantly at railroad yards, train stations, and train stops. Most train idling emissions are concentrated at railroad yards, where switching engines and local yard service operations are performed. Train idling averages from 6 to 10 hours per train per day. Due to difficulty in cold starting and possible costly damage to the locomotive's diesel-powered engine, train idling has been a common practice in the rail industry for decades.

There are four railroad companies that serve the Basin. The companies are Amtrak, Metrolink, Santa Fe, and Union Pacific. Amtrak and Metrolink operate passenger trains solely for interstate/cross-country and local transportation, respectively. Train idling emissions are generated during stops made at each train station. Santa Fe and Union Pacific offer freight, yard, and local services. Idling emissions from these trains are emitted in several major railroad yards locations, namely:

- Los Angeles - Taylor Yard
- Los Angeles – 750 Lamar St.
- Los Angeles – 8th and Santa Fe
- Long Beach – Anaheim and Sampson
- Long Beach – 2401 E. Sepulveda
- Watson – West of Long Beach
- City of Commerce – Indiana and Washington
- City of Commerce – Washington and Oak
- City of Industry – 650 S. Stimson
- West Colton – 19100 Slover Ave.
- San Bernardino – 4th and 15 Freeway
- Riverside 3rd and Vine St.

Table 4. Information Necessary to Calculate Diesel Particulate Emissions from Train Idling.

<u>Train Operations Data</u>

- number of trains idling per location
- frequency of trains idling per location
- average idle time per day per locomotive per location, hr/day

<u>Locomotive Engine and Fuel Data</u>

- locomotive horsepower rating, hp
- fuel consumption while idling, gal/hr

- fuel density, lb/gal
- brake specific fuel consumption, lb/hp-hr
- DPM emission factor, g/hp-hr

For the latest emissions data on locomotives in the SCAB, refer to the report entitled, *Emissions from Locomotives in the Modeling Region for the South Coast Air Quality Management District*.[6] Emission factors for locomotives, can be found from the U.S. EPA's report titled, *Technical Highlights- Emission Factors for Locomotives*.[7]

Table 4 summarizes the information required to estimate DPM emissions from train idling.

Dispersion Modeling

Model Selection

The latest version of U.S. Environmental Protection Agency (U.S. EPA) air quality dispersion model, called ISCST3 (Industrial Source Complex – Short Term, Version 3)[8] should be used for estimating the impacts. ISCST3 is a Gaussian plume model capable of estimating pollutant concentrations from a wide variety of sources that are typically present in an industrial source complex. Emission sources are categorized into four basic types: point, area, volume, and open pit sources. ISCST3 estimates hourly concentrations for each source/receptor pair and calculates concentrations for user-specified averaging times, including an average concentration for the complete simulation period.

ISCST3 should be executed using the urban dispersion parameters (i.e., URBAN control option), which is SCAQMD policy for all permitting in its jurisdiction. The U.S. EPA regulatory defaults options are implemented except that the calm processing option is disabled (i.e., NOCALM control option).

Source Treatment

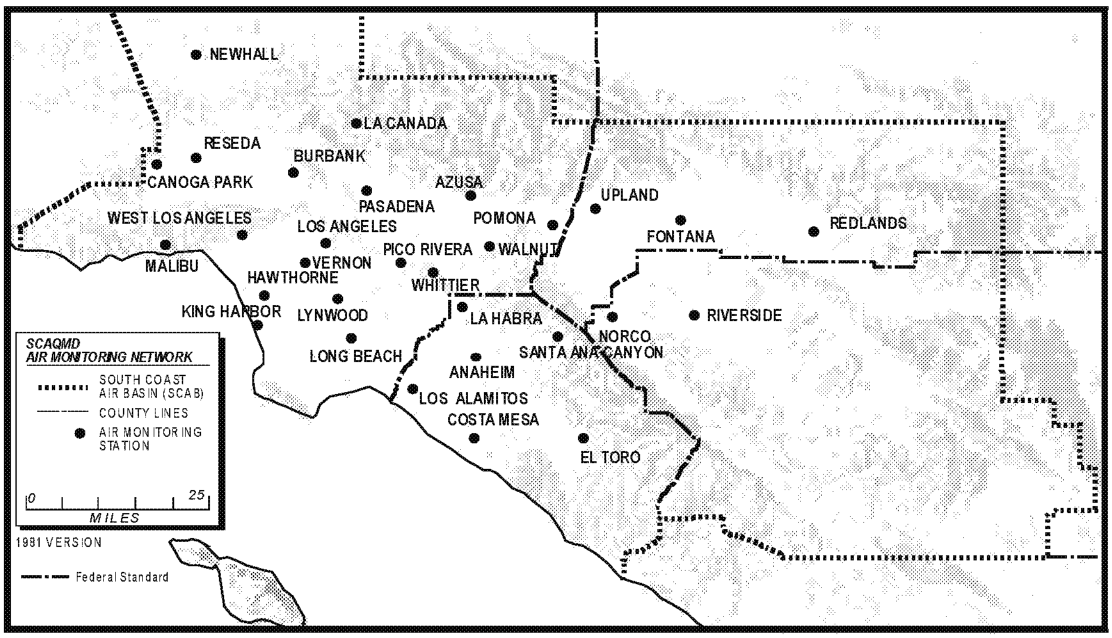
The volume or area source options of ISCST3 are most appropriate for the DPM sources associated with truck idling and movement. Multiple, adjacent volume (or area) sources could be used to simulate a roadway. The reader is referred to the ISCST3 user's guide for guidance in this area.[8] Individuals preparing impact assessments are referred to ARB for guidance regarding source parameters and source activity assumptions.[5] Significant deviations from the assumptions outlined in *Appendix VII: Risk Characterization Scenarios* should be justified.

The point source treatment of ISCST3 is most appropriate for ship activity and train idling emissions. Multiple, adjacent point sources could be used to simulate ship maneuvering within local ports and train movement within railroad yards.

Meteorological Data

District has 1981 meteorological data (i.e., hourly winds, atmospheric stability, and mixing heights) at 35 stations in the Basin, as shown in Figure 1 and listed in Table 5. These data are in a format which can be directly read by ISCST3. The nearest representative meteorological station should be chosen for modeling. Usually this is simply the nearest station; however, an intervening terrain feature may dictate the use of an alternate station. Individuals may contact District staff regarding the most representative meteorological station if necessary. The data are available on the SCAQMD's website.[9]

Figure 1. Meteorological Monitoring Stations in the South Coast Air Basin



Receptor Grid

The receptor grid should begin at the facility fence line or transportation right-of-way and extend to an adequate distance from the site to cover the facility's impact area. The peak annual DPM concentrations should be identified using 100-meter receptor grid. A map showing the emission sources and the receptor grid with actual coordinates used in the modeling should be provided. Discrete receptors should also be located at sensitive receptors (e.g., schools, day-care centers, hospitals, etc.) in the impact area (i.e., the area where impacts are greater than 1 in a million).

Table 5. Locations of Meteorological Stations.

	UTM Coordinates (m)		Lat./Long. Coordinates	
Station name	**E-W**	**N-S**	**Latitude**	**Longitude**
Anaheim	415.0	3742.5	33°49'16"	117°55'07"
Azusa	414.9	3777.4	34°08'09"	117°55'23"
Banning	510.5	3754.5	33°55'58"	116°53'11"
Burbank	379.5	3783.0	34°10'58"	118°18'27"
Canoga Park	352.9	3786.0	34°12'23"	118°35'48"
Compton	385.5	3750.3	33°53'19"	118°14'17"
Costa Mesa	413.8	3724.2	33°39'21"	117°55'47"
Downtown Los Angeles	386.9	3770.1	34°04'02"	118°13'31"
El Toro	436.0	3720.9	33°37'39"	117°41'25"
Fontana	455.4	3773.9	34°06'24"	117°29'01"
Indio	572.3	3731.0	33°43'06"	116°13'11"
King Harbor	371.2	3744.4	33°50'00"	118°23'30"
La Canada	388.2	3786.1	34°12'42"	118°12'49"
La Habra	412.0	3754.0	33°55'28"	117°57'07"
Lancaster	396.0	3839.5	34°41'38"	118°08'08"
Lennox	373.0	3755.0	33°55'46"	118°22'26"
Long Beach	390.0	3743.0	33°49'24"	118°11'19"
Los Alamitos	404.5	3739.8	33°47'45"	118°01'54"
Lynwood	388.0	3754.0	33°55'20"	118°12'42"
Malibu	344.0	3766.9	34°01'59"	118°41'23"
Newhall	355.5	3805.5	34°22'59"	118°31'02"
Norco	446.8	3749.0	33°52'54"	117°34'31"
Palm Springs	542.5	3742.5	33°49'25"	116°32'27"
Pasadena	396.0	3778.5	34°08'38"	118°07'41"
Pico Rivera	402.3	3764.1	34°00'53"	118°03'29"
Pomona	430.8	3769.6	34°03'60"	117°44'60"
Redlands	486.2	3769.4	34°04'00"	117°09'00"
Reseda	359.0	3785.0	34°11'54"	118°31'49"
Riverside	464.8	3758.6	33°58'10"	117°22'50"
Santa Ana Canyon	431.0	3748.4	33°52'32"	117°44'46"
Upland	440.0	3773.1	34°05'55"	117°39'02"
Vernon	387.4	3762.5	33°59'55"	118°13'10"
Walnut	420.0	3761.7	33°59'41"	117°51'58"
West Los Angeles	372.3	3768.6	34°03'08"	118°23'01"
Whittier	405.3	3754.0	33°55'26"	118°01'28"

Estimation of Health Risks

Cancer Risks

The cancer risks from DPM occur exclusively through the inhalation pathway; therefore the cancer risks can be estimated from the following equation:

$$CR_{DPM} = C_{DPM} \cdot URF_{DPM} \cdot LEA$$

where,

CR_{DPM} Cancer risk from diesel particulate matter; the probability of an individual developing cancer as a result of exposure to DPM.

C_{DPM} Annual average DPM concentration in $\mu g/m^3$.

URF_{DPM} Unit risk factor for DPM; estimated probability that a person will contract cancer as a result of inhalation of a DPM concentration of 1 $\mu g/m^3$ continuously over a period pf 70 years.

LEA Lifetime exposure adjustment; values range from 0.14 to 1.0; see the discussion below.

The inhalation unit risk factor for diesel particulate was established by ARB as 300 in one million per continuous exposure of 1 $\mu g/m^3$ of DPM over a 70-year period.[1] The latest unit risk factors should always be used in the impact assessment (see reference #10 for a link to the latest toxicity values.)

In order to protect public health, and in accordance with the recommendations of the State of California Office of Environmental Health Hazard Assessment (OEHHA), a 70-year lifetime exposure is assumed for all receptor locations except for off-site workers (i.e., receptor locations in commercial or industrial areas). The LEA for all residential or sensitive receptors is 1.0.

It is recognized that exposures for off-site workers in commercial or industrial areas are less than 70 years. Exposure adjustments for these off-site workers are allowed as follows. When the facility and its equipment operate continuously (i.e., 24 hrs/day and 365 days/yr), the LEA for an off-site worker is 0.14 (i.e., [8 hr/day • 240 days/yr • 46 yrs]/[24 hrs/day • 365 days/yr • 70 yrs]). For all other facility operating schedules, the LEA for an off-site worker is 0.66 (i.e., 46 yr/70 yr).

A cancer risk isopleth map showing risk contours of 1, 10, and 25 in a million should be included in the impact assessment.

Non-cancer Risks

The relationship for the non-cancer health effects of DPM is given by the following equation:

$$HI_{DPM} = C_{DPM}/REL_{DPM}$$

where,

HI_{DPM} Hazard Index; an expression of the potential for non-cancer health effects.

C_{DPM} Annual average DPM concentration ($\mu g/m^3$).

REL_{DPM} Reference exposure level (REL) for DPM; the DPM concentration at which no adverse health effects are anticipated.

The chronic REL for DPM was established by OEHHA as 5 µg/m^3. The latest RELs should always be used in the impact assessment (see reference #10 for a link to the latest toxicity values.)

Potential Mitigation Measures

CEQA requires public agencies to take responsibility for protecting the environment. In regulating public or private projects, agencies are expected to avoid or minimize environmental damage. The purpose of an EIR is to identify the significant effects of a project on the environment, identify alternatives to the project, and indicate the manner in which significant impacts can be mitigated or avoided. To this end, below is a list of potentially applicable mitigation measures for truck idling facilities, shipping activities in local ports, and train idling.

Truck Idling Facilities

- Provide a minimum buffer zone of 300 meters between truck traffic and sensitive receptors;
- Re-route truck traffic by adding direct off-ramps for the truck traffic or by restricting truck traffic on certain sensitive routes;
- Improve traffic flow by signal synchronization;
- Enforce truck parking restrictions;
- Develop park and ride programs;
- Restrict truck idling;
- Restrict operation to "clean" trucks;
- Electrify service equipment at facility;
- Provide electrical hook-ups for trucks that need to cool their load;
- Electrify auxiliary power units;
- Use "clean" street sweepers;
- Pave roads and road shoulders;
- Provide onsite services to minimize truck traffic in or near residential areas, including, but not limited to, the following services: meal or cafeteria service, automated teller machines, etc;
- Require or provide incentives to use low-sulfur diesel fuel with particulate traps; and
- Conduct air quality monitoring at sensitive receptors.

Ship Hotelling at Local Ports

- Require the use of land-based power when berthed;

- Limit the sulfur content of fuel used by ships in the South Coast waters; and
- Install add-on DPM control device to diesel-fueled auxiliary engines and boilers.

Train Idling

- Change Railroad Operating Practices - Reducing idle time would definitely reduce DPM emissions. Locomotives that are not in use generally idle. Locomotive manufacturers indicate that engines could be shut-down and restarted when ambient temperatures are above 50°F, which is nearly always the case in southern California.
- Idle Reduction Technologies - The rail industry has developed and designed a new Auxiliary Power Unit (APU) system that provides power during idling conditions and shuts down the main locomotive engine. Installing APU system reduces locomotive PM emissions by 84 percent. Significant reduction in diesel fuel consumption also results when the main locomotive engine is shuts down automatically by the APU system.
- Research and Development of New Engine Technologies - Modifying fuel injectors which includes fuel injection pressure, fuel spray pattern, injection rate and timing has been found to reduce emissions from locomotive diesel engines. Development of low NO_X locomotive engine is based on similar principle used in low NO_X engines for stationary power industry. Retardation of fuel injection can achieve significant NO_X emission reductions.

References

(1) Proposed Identification of Diesel Exhaust as a Toxic Air Contaminant. ARB and OEHHA. April 22, 1998.

(2) Final Report on MATES-II. SCAQMD. March 2000.

(3) Refer to the following link to ARB's website for the latest version of EMFAC and its documentation: http://www.arb.ca.gov/msei/on-road/onroad_index.htm.

(4) Risk Reduction Plan to Reduce Particulate Matter Emissions from Diesel-Fueled Engines and Vehicles. Appendix VII – Risk Characterization Scenarios. ARB. October 2000.

(5) Marine Vessels Emissions Inventory Update to 1996 Report: Marine Vessel Emissions Inventory and Control Strategies. Prepared for the South Coast A.Q.M.D by Charlotte Pera and Diana Popek of ARCADIS Geraghty and Miller, Inc., Mountain View, California. September 23, 1999.

(6) Emissions from Locomotives in the Modeling Region for the South Coast Air Quality Management District. Final Technical Report III-H, Air Quality Management Plan 1991 Revision. Prepared by Booz-Allen & Hamilton Inc. July 1990.

(7) Technical Highlights - Emission Factors for Locomotives. EPA420-F-97-051. December 1997. Refer to the following link: http://www.epa.gov/otaq/regs/nonroad/locomotv/frm/42097051.pdf

(8) Refer to the following links to U.S. EPA's website for the latest version of ISCST3 and its documentation: http://www.epa.gov/scram001/tt22.htm#isc.

(9) Refer to the following link to SCAQMD's website to obtain meteorological data for dispersion modeling: http://www.aqmd.gov/metdata/.

(10) Refer to the following link to ARB's website for the latest toxicity values: http://www.arb.ca.gov/toxics/healthval/healthval.htm.