



BAY AREA  
AIR QUALITY  
MANAGEMENT  
DISTRICT

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# Permitted Stationary Source Risk and Hazards Screening Tool Methodology

Stationary sources of air pollution—including complex sources such as metal smelting, wastewater treatment plants, and refineries as well as smaller facilities such as diesel generators, gasoline dispensing facilities (GDFs or gas stations), and boilers—are regulated and subject to permit conditions established by the District. The District maintains a database of its permitted sources and their associated emissions. These emissions are determined either through direct measurement via source test or by engineering calculation based on process throughput and industry emission factors. Emissions from all permitted facilities are reported annually to the California Air Resources Board (CARB) under the California Emissions Inventory Development and Reporting System (CEIDARS, CARB 2013<sup>1</sup>) and, subsequently, reported to US Environmental Protection Agency (EPA) to supplement the National Emissions Inventory database (NEI, EPA 2014<sup>2</sup>).

The CEIDARS report formed the basis of the permitted source inventory for the CEQA risk and hazards screening tool. The inventory focused on fine particulate matter less than 2.5 microns in diameter (PM<sub>2.5</sub>) and toxic air contaminants (TACs) including diesel particulate matter (DPM). DPM is used as a surrogate to represent all carcinogenic compounds associated with the combustion of diesel fuel used by standby generators and fire pumps. Individual toxic compounds were included in the analysis if the generator used other types of fuel such as natural gas.

The current report differed from previous version by including GDFs in the point-source inventory. Historically, emissions from GDFs have been aggregated and reported as part of county-level area totals in CEIDARS. The current database includes over 2,265 retail and nonretail GDFs geolocated with actual or permitted throughputs used to estimate their emissions.

Using emissions data specific to each stationary source, the Air District developed the CEQA risk and hazards screening tool that estimates screening level cancer risks, chronic hazard index, and fine PM concentrations at the centroid of the facility. The screening level cancer risks and fine PM concentrations are estimated to be intentionally conservative and are based upon worst-case assumptions.

The screening tool contains the following information:

- Unique plant number assigned by the District. Most plant numbers greater than 100,000 represent retail and non-retail gasoline dispensing facilities;
- Plant name and address;
- Centroid location of the plant based on UTM NAD83 Zone 10 datum; PlantNumber\_SourceNumber combination denote the location of the backup generator as provided based on responses to an Air District survey by the facility representative;
- Chronic cancer risk (in millions) and hazard indices for the combined emissions associated with each plant based on conservative assumptions; and
- Conservatively estimated PM<sub>2.5</sub> concentrations in units of micrograms per cubic meters.

<sup>1</sup> CEIDARS 2.5 Database Structure can be found at <https://www.arb.ca.gov/ei/drei/maintain/dbstruct.htm>

<sup>2</sup> EPA NEI web page can be found at: <https://www.epa.gov/air-emissions-inventories>

The screening level risks and hazards were estimated by multiplying the CEIDARS emissions with conservative exposure assumptions. For permitted sources (excluding gasoline dispensing facilities (GDFs)), a cavity effects screening procedure was used to model aerodynamic downwash from nearby buildings for worst case one-hour ambient air concentrations. The methodology conservatively estimates the buildup of pollution at a receptor located immediately adjacent to the lee side of the building, depicting worst case dispersion. From EPA's Screening Procedures for Estimating the Air Quality Impact of Stationary Sources (1992), the cavity equation is as follows:

$$\text{Air Concentration (1 hour maximum)} = Q / (1.5 \times A \times u)$$

Where:

Concentration	=	One hour maximum exposure concentration at the fenceline of the plant (ug/m <sup>3</sup> );
Q	=	Emission rate (g/sec);
A	=	Cross section area of the building normal to the wind (m <sup>2</sup> ); and
U	=	Wind speed (m/sec).

Building cross section was assumed to be 25 feet high by 40 feet wide, approximately 92.7 square meters. Calm winds of two meters per second, taken from EPA's screening modeling guidelines, was used. The maximum one-hour concentration, estimated by applying these factors, was then multiplied by 0.1 to convert the one-hour concentration to an annual average concentration, for estimating risks and hazards.

A different modeling methodology was used to handle emissions from gasoline dispensing facilities to handle the complex dispersions associated with losses from spills, pipe vents, and pumps. EPA's AERMOD atmospheric dispersion model was used to develop worst-case ground-level annual concentrations. AERMOD compatible meteorological files were processed for representative Bay Area cities including Concord, Hunters Point in San Francisco, Oakland Airport, Petaluma Airport, UC Richmond Campus, and San Jose Airport using AERMET. Over two dozen different building configurations were modeled to quantify building downwash effects. GDF emissions were apportioned by assigning a majority of the losses (92.7%) to dispensers and a small fraction (7.3%) to vents. Given that most gas stations have similar sized vents from their underground tanks, storage tank vents were consistently modeled as point sources of 10 feet height and two-inch diameter; exhaust gas velocity of 0.00035 meters per second and exhaust temperature of 294 degrees Kelvin. Six dispenser were modeled in each run and refueling and spillage were modeled as volume sources with an initial lateral dimension of 2.3 feet.

For each building configuration and meteorological data set, the annual average atmospheric dispersion factor (also known as Chi/Q) was estimated using AERMOD. The Chi/Q factor, the ratio of the pollutant ground level concentration (Chi) to the source emission (Q) at specified distances and directions from the source, describes the dilution and dispersal effects caused by the atmosphere once the pollutant is released. GDF ground-level concentrations were estimated by multiplying the chemical-specific emissions by the area-specific Chi/Q using the most conservative building configuration. County-specific Chi/Q are presented in Table 1.

**Table 1: Area-specific Chi/Q for GDFs**

County	Chi/Q (ug/m <sup>3</sup> per gram/sec)
Alameda	3782
Contra Costa	5287
Solano	6236
Marin	6236
Napa	6236
Santa Clara	3420
San Francisco	4585
San Mateo	6236
Sonoma	6236

In most cases, emission data were taken from the CEIDARS report. Operators report their facility emissions annually or bi-annually depending on their permit cycle. Unlike most stationary sources, GDF emissions are reported to CARB as county-wide estimates rather than on an individual facility-basis. To quantify emissions per gas station, the Air District used reported annual throughputs conducted during facility inspections. If inspection throughputs were unavailable, permit throughputs were used. Individual chemical emissions for gas station specific compounds (i.e, benzene, toluene, ethylbenzene, naphthalene, xylenes, and hexane) were estimated by multiplying the station throughput by CARB emission factors.

Cancer risks were estimated by multiplying the Chi/Q, chemical-specific emissions, exposure factors, and chemical toxicity factors for each station. Cancer risk is the incremental probability that an individual will develop cancer over a lifetime as a direct result of exposure to potential carcinogens from anthropogenic sources. The estimated risk is a unitless probability, often expressed as the number of people who might experience cancer per million people similarly exposed.

The cancer risk methodology follows guidelines from Cal/EPA's Office of Environmental Health Hazard Assessment (OEHHA) and the risk management guidance for stationary sources adopted by the California Air Resources Board (CARB) and the California Air Pollution Control Officers Association (CAPCOA). Cancer risks were calculated over an assumed 70-year lifetime by multiplying the annual average chemical concentrations by the chemical intakes and the chemical-specific potency factors (CPFs). The chemical concentrations were modeled, in most cases, from the point of release to the exposure point at the downwind residential locations. Contributions from all individual sources were then summed by facility for cancer risks. The chemical intake or dose describes the frequency and duration of the exposure, estimated using the breathing rates, exposure durations, and exposure frequencies. In accordance with OEHHA's revised health risk assessment guidelines<sup>3</sup>, the intake methodology was updated to address children's greater sensitivity and health impacts from early exposure to carcinogenic compounds. The updated calculation procedures include the use of age-specific weighting factors, breathing rates, fraction of time at home, and reduced exposure durations. Each factor is described below:

- Age Sensitivity Factor (ASFs) account for the heightened sensitivity of children to carcinogens during fetal development and early childhood. Consistent with OEHHA, the Air District uses a factor of 10 for exposures that occur from the third trimester of pregnancy to two years of age, three for exposures that occur from two years through 15 years of age, and one for all other age groups. The Air District has been incorporating ASFs in its air permits since 2010.

<sup>3</sup> OEHHA, 2015. Air Toxics Hot Spots Program Guidance Manual for the Preparation of Health Risk Assessments 2015. Available at: <http://oehha.ca.gov/air/cmr/notice-adoption-air-toxics-hot-spots-program-guidance-manual-preparation-health-risk-0>

- Daily Breathing Rates (DBR) is the age-specific daily air intake. OEHHA developed a range of rates for four age groups: last trimester to newborn, newborn to two years of age, two years to 16 years of age, and older than 16 years of age. CAPCOA and CARB recently recommended the use of 95<sup>th</sup> percentile breathing rates for the most sensitive age group (less than two years of age) and 80<sup>th</sup> percentile for all other age groups.
- Fraction of Time at Home (FAH) refers to the estimated amount of time residents stay at home. In past HRAs, the Air District assumed that residents are home 24 hours a day, 7 days a week. OEHHA in its 2015 Risk Assessment Guidance is recommending less than 100% of time based on population and activity statistics. Consistent with OEHHA, the PHP tool incorporates a FAH of 0.73 for 16 year olds and above and one for under 16 to address exposures at local schools in close proximity to emitting facilities.
- Exposure Duration (ED) is the length of time an individual is continuous exposed to air toxics. Previously, the Air District used a 70 year lifetime exposure duration for residents over a 70 year lifespan. Based on updated demographic data, the Air District follows OEHHA recommendation of 30 year exposure duration, consistent with US EPA, for residents.

**Table 2: Summary of the factors used in the screening tool.**

Factor	Units	Age Groups			
		Last Trimester to Newborn	0 to 2 years old	2 to 16 years old	>16 years
Daily breathing rates (DBR)	L/kg-day	361	1090	572	261
Age Sensitivity (ASF)	unitless	10	10	3	1
Fraction of time at home (FAH)	unitless	1	1	1	0.73
Exposure duration (ED)	years	0.25	2	14	14

The equation used to calculate the dose for the inhalation pathway is as follows:

$$Dose_i = \left( CF \times EF \times \sum_j^{30 \text{ years}} \{ C_{i,j} \times DBR_j \times FAH_j \times ED_j \times ASF_j \} \right) \div AT$$

Where:

$Dose_i$	=	Accumulated dose for an individual breathing carcinogen $i$ for 30 continuous years (mg/kg-day)
$CF$	=	conversion factor ( $10^{-6}$ mg-m <sup>3</sup> /μg-L)
$EF$	=	Exposure frequency (350 days per year <sup>4</sup> )
$DBR_j$	=	Daily breathing rate during year $j$ (L/kg-day)
$FAH_j$	=	Fraction of time at home during year $j$ (unitless)
$ED_j$	=	Exposure duration of year $j$ (years)
$C_{i,j}$	=	Annual average concentration for pollutant $i$ during year $j$ (μg/m <sup>3</sup> ) equal to the emission rate (g/sec) multiplied by the source type Chi/Q (dilution factor ug/m <sup>3</sup> per g/sec)
$ASF_j$	=	Age Sensitivity Factor for year $j$ ; the value of the factor is higher in early years of exposure (unitless)
$AT$	=	Averaging time (25,550 days, equivalent to 70 year lifespan)

<sup>4</sup> Screening tool uses an exposure frequency of 350 days per year consistent with OEHHA and EPA guidance. 350 days per year represent the number of days an individual will reside in their home less approximately, two weeks of vacation.

The cancer risk is equal to the dose multiplied by the chemical-specific CPF. In most cases, CPF specific for the inhalation pathways were used. However, some chemicals, in addition to being inhaled, can deposit on the ground in particulate form and contribute to risk through ingestion of soil or through other routes. To account for the additional risks from exposure to non-inhalation pathways, multi-pathway CPFs were used where available from OEHHA. Risks were not estimated for chemicals lacking OEHHA approved toxicity values. The total per million cancer risk is then the sum of the pollutant specific risk values.

The screening tool also evaluated the hazard associated with chronic exposures to non-carcinogenic compounds. The potential for chronic non-cancer hazards is evaluated by comparing the long term exposure level and intake by the chronic reference exposure level (REL). The REL is used as an indicator of potential adverse non-cancer health effects, and refers to a concentration ( $\mu\text{g}/\text{m}^3$ ) at which no adverse health effects are anticipated. The RELs used in this tool are published by OEHHA. Noncancer chronic hazard are calculated by dividing the chemical-specific REL by the annual average concentration. The equation for estimating the hazard quotient is:

$$HQ_i = C_{i,j} \div REL_i$$

Where:

$HQ_i$	=	Accumulated dose for an individual breathing carcinogen $i$ for 30 continuous years (mg/kg-day)
$C_{i,j}$	=	Annual average concentration for pollutant $i$ during year $j$ ( $\mu\text{g}/\text{m}^3$ ) equal to the emission rate (g/sec) multiplied by the source type $Chi/Q$ (dilution factor $\mu\text{g}/\text{m}^3$ per g/sec)
$REL_i$	=	Chronic noncancer reference exposure level for chemical $i$ (mg/kg-day)

Multi-pathway RELs were used, when available from OEHHA, to account for additional exposures through non-inhalation pathways. The hazard index (HI) is the sum of the individual HQs for TACs identified as affecting the same target organ or organ systems. To conservatism, all HQs were summed regardless of target organ.

The modeled screening level impacts are not representative of actual health risks. Rather, the values are upper-bound estimates for assessing whether a site-specific health risk assessment is warranted. The screening approach relies on numerous defaults, conservative assumptions that are not facility specific nor are the estimates reflective of actual cancer risks likely to be experienced by nearby receptors.