Appendix G

Health Risk Evaluation

A. Introduction

In 1995, State law (California Health and Safety Code (HSC) §§ 41750 through 41755) required the Air Resources Board (ARB) to establish a uniform statewide program for the voluntary registration and regulation of portable engines and equipment units in California. In 1997, ARB adopted the Statewide Portable Equipment Registration Program (PERP) Regulation, which defined the equipment allowed to register in PERP, set operational limits for registered equipment, established registration procedures, and set registration fees.

The Portable Engine Airborne Toxic Control Measure (ATCM) is a regulation adopted in 2004 (and subsequently amended in 2011) as part of a broad initiative, called the Diesel Risk Reduction Plan, which set emissions requirements for portable engines to reduce exposure to toxic diesel particulate matter (diesel PM) and protect public health. The ATCM works in concert with the PERP Regulation to allow fleets to voluntarily register portable equipment used across California with the State rather than permitting or registering the equipment with each local air district individually.

As a technology-forcing regulation, the ATCM was designed to force the development of retrofit emissions control technologies and new engine technologies to meet regulatory requirements. Some of these technologies materialized, though not as early as anticipated. In return, the cost to regulated parties has increased compared to the estimated cost at the time of ATCM adoption.

ARB staff is proposing to amend the PERP Regulation and ATCM to provide relief from the technologically and financially challenging 2017 and 2020 fleet average emission standards set by the current ATCM, while also safeguarding public health benefits by ensuring the emissions reductions envisioned in the original ATCM will be met.

To help evaluate the potential health impacts from the proposed amendments, this document compares the projected cancer and non-cancer health risks associated with diesel PM from portable, including PERP and District permitted, engines using the portable regulatory amendment scenarios described in the following section.

B. Portable Regulatory Amendment Scenarios

The projected cancer risk associated with diesel PM from portable engines largely depends on fleet turnover, or the rate at which older, higher emitting engines are replaced with newer, lower emitting engines. This fleet turnover is driven by the regulations in place, the compliance dates in those regulations, and the requirements of those compliance standards when those compliance dates become effective. The projected cancer risk was estimated under the four scenarios described below:

1. <u>Business As Usual (BAU)</u> –This scenario is used as a baseline based on projected fleet compliance rates under the current ATCM. To clarify, the diesel PM emissions used in this scenario are not solely based on the current ATCM fleet standard compliance dates shown in Table G-1. Instead, the BAU accounts for the fraction of fleets forecasted to be operating out of compliance due to the technologically and financially challenging 2017 and 2020 fleet

average emission standards set by the current ATCM. The increase emissions associated with fleets operating out of compliance are presented in Table G-10.

For more information on how the BAU fleet compliance path selection were derived, please refer to Section A in *Appendix C - Proposed Portable Equipment Regulation and ATCM Amendments Standardized Regulatory Impact Assessment*.

Table G-1: Existing Fleet Average Standards for All Fleets

Fleet Standard Compliance Date	Engines <175 hp (g/bhp-hr)	Engines 175-750 hp (g/bhp-hr)	Engines >750 hp (g/bhp-hr)
1/1/2013	0.30	0.15	0.25
1/1/2017	0.18	0.08	0.08
1/1/2020	0.04	0.02	0.02

2. <u>Proposed Regulatory Amendments</u> – This scenario represents the combination of the tier phase-out schedule with the option of fleet averaging for large fleets as shown in Table G-2 and G-3. To calculate health risk under this scenario, staff set criteria to predict which fleets would follow the tier phase-out schedule and which large fleets would follow the fleet averaging schedule. These criteria were based on the current fleet's oldest engine and fleet average. This resulted in a projected rate of 67% of large fleets following the tier phase-out and 33% of large fleets following the fleet average.

For more information on how the proposed regulatory amendment fleet compliance path selection were derived, please refer to Section C in *Appendix C - Proposed Portable Equipment Regulation and ATCM Amendments Standardized Regulatory Impact Assessment*.

Table G-2: Proposed Amendments' Tier Phase-Out Schedule

	Engines rated 50 to 750 bhp		
	Large Fleet[1]	Small Fleet[2]	
Tier 1	1/1/2020	1/1/2020	1/1/2022
Tier 2 built prior to 1/1/2009	1/1/2022	1/1/2023	1/1/2025
Tier 2 built on or after 1/1/2009	N/A	N/A	1/1/2027
Tier 3 built prior to 1/1/2009	1/1/2025	1/1/2027	N/A
Tier 3 built on or after 1/1/2009	1/1/2027	1/1/2029	N/A
Flexibility engines (Tier 1,2, and 3)[3]	December 31 of the year 17 years after the date of manufacture		

[1] Large fleets are those that exceed 750 total combined break horsepower (bhp); they will have the option to follow a tier phase-out schedule, or comply with a set of fleet average standards.
[2] Small fleets will be those with less than or equal to 750 total combined horsepower.
[3] The Transitional Program for Equipment Manufacturers (TPEM), a federal program designed to provide flexibility to equipment manufacturers as they transition to building equipment with only the newest tier engines, contains provisions which allow equipment manufacturers to sell up to 80% of their equipment with engines certified to the previous tier after a new tier requirement becomes effective.

Table G-3: Proposed Amendments' Fleet Average Options for Large Fleets[1]

Proposed Compliance Date	ARB Proposed Fleet PM Standard (g/bhp-hr)
1/1/2020	0.10
1/1/2023	0.06
1/1/2027	0.03

[1] Large fleets are those that exceed 750 total combined break horsepower (bhp); they will have the option to follow a tier phase-out schedule, or comply with a set of fleet average standards.

3. <u>Alternative #1</u> – This scenario is similar in concept to the proposed regulatory amendments as it is a combination of a tier phase-out with the option of fleet averaging standards for large fleets as shown in Tables G-4 and G-5. The largest difference being one additional year of engine life under the tier phase-out and higher fleet averaging standards under the fleet averaging option for large fleets. In addition, a different set of criteria was used to predict which fleets would follow the tier phase-out or fleet averaging compliance path. Results projected 50% of large fleets would follow the tier phase-out schedule and 50% of large fleets would follow the fleet averaging schedule.

For more information on how the Alternative #1 fleet compliance path selection were derived, please refer to Section E in *Appendix C - Proposed Portable Equipment Regulation and ATCM Amendments Standardized Regulatory Impact Assessment*.

Table G-4: Alternative #1 Tier Phase-Out Schedule

	Engines rated 50 to 750 bhp		
	Large Fleet[1]	Small Fleet[2]	
Tier 1	1/1/2020	1/1/2020	1/1/2022
Tier 2	1/1/2023	1/1/2025	1/1/2027
Tier 3 built prior to 1/1/2009	1/1/2026	1/1/2028	N/A
Tier 3 built on or after 1/1/2009	1/1/2028	1/1/2030	N/A
Flexibility engines (Tier 1,2, and 3)[3]	December 31 of the year 18 years after the date of manufacture		

[1] Large fleets are those that exceed 750 total combined break horsepower (bhp); they will have the option to follow a tier phase-out schedule, or comply with a set of fleet average standards.
[2] Small fleets will be those with less than or equal to 750 total combined horsepower.
[3] The Transitional Program for Equipment Manufacturers (TPEM), a federal program designed to provide flexibility to equipment manufacturers as they transition to building equipment with only the newest tier engines, contains provisions which allow equipment manufacturers to sell up to 80% of their equipment with engines certified to the previous tier after a new tier requirement becomes effective.

Table G-5: Alternative #1 Fleet Average Options for Large Fleets[1]

Proposed Compliance Date	ARB Proposed Fleet PM Standard (g/bhp-hr)
1/1/2020	0.12
1/1/2023	0.09
1/1/2027	0.06

[1] Large fleets are those that exceed 750 total combined break horsepower (bhp); they will have the option to follow a tier phase-out schedule, or comply with a set of fleet average standards.

4. <u>Alternative #2</u> – This scenario represents a more stringent set of standards compared to the proposed regulatory amendments that includes a combination of tier phase-out with the option of fleet averaging for large fleets with final compliance dates of 2025, as shown in Tables G-6 and G-7. The criteria to predict which fleets would follow the tier phase-out schedule and which large fleets would follow the fleet averaging schedule were the same as the proposed regulatory amendments with 67% of fleets following the tier phase-out and 33% of fleets following the fleet average.

For more information on how the Alternative #2 fleet compliance path selection were derived, please refer to Section E in *Appendix C - Proposed Portable Equipment Regulation and ATCM Amendments Standardized Regulatory Impact Assessment*.

Table G-6: Alternative #2 Tier Phase-Out Schedule

	Engines rated 50 to 750 bhp		
	Large Fleet[1]	Small Fleet[2]	
Tier 1	1/1/2020	1/1/2020	1/1/2022
Tier 2	1/1/2022	1/1/2022	1/1/2025
Tier 3	1/1/2025	1/1/2025	N/A
Flexibility engines (Tier 1,2, and 3)[3]	Treated as the Tier the engine was built to		

[1] Large fleets are those that exceed 750 total combined break horsepower (bhp); they will have the option to follow a tier phase-out schedule, or comply with a set of fleet average standards.
[2] Small fleets will be those with less than or equal to 750 total combined horsepower.
[3] The Transitional Program for Equipment Manufacturers (TPEM), a federal program designed to provide flexibility to equipment manufacturers as they transition to building equipment with only the newest tier engines, contains provisions which allow equipment manufacturers to sell up to 80% of their equipment with engines certified to the previous tier after a new tier requirement becomes effective.

Table G-7: Alternative #2 Fleet Average Options for Large Fleets[1]

Proposed Compliance Date	ARB Proposed Fleet PM Standard (g/bhp-hr)
1/1/2020	0.10
1/1/2023	0.06
1/1/2025	0.03

[1] Large fleets are those that exceed 750 total combined break horsepower (bhp); they will have the option to follow a tier phase-out schedule, or comply with a set of fleet average standards.

C. Overview of the Methodology

A portable engine is defined as an engine designed to be and is capable of, being carried or moved from one location to another and will not reside at the same location for more than twelve consecutive months. Portable diesel powered engines are transient in nature, where operation time can fluctuate from just a few hours up to one year, and they can be used in a variety of equipment (i.e., generators, compressors, pumps, etc.) that may be moved within the facility. It is difficult to formulate an operational scenario that would be representative of typical use. Instead, staff used a combination of ambient diesel PM data and ARB emission inventory data to estimate potential health impacts. To help view the trends of each scenario, staff evaluated the cancer risks across multiple years from 2012 to 2031 for the South Coast Air Basin.

The South Coast Air Basin was used since it represents approximately 40 percent of the engines registered in PERP, as shown in the table below, and would represent an upper bound estimation of the risks.

Table G-8: Registered PERP Engines and Total Emissions for Air Districts with Greatest Number of PERP Registered Engines

California Air District	Total Portable Engine Registrations with Home District Designation	Total Portable Diesel PM Emissions (tpd)[1]	Percentage of Portable Diesel Engines in PERP Inventory[2]
South Coast AQMD	11,793	0.413	39.2%
Bay Area AQMD	5,505	0.260	18.3%
San Joaquin Valley APCD	5,356	0.168	17.8%
San Diego APCD	1,631	0.055	5.4%
Sacramento Metro AQMD	1,090	0.029	3.6%
Yolo-Solano AQMD	933	0.033	3.1%

[1] Total portable diesel PM emissions in tons per day is calculated from ARB Emissions Inventory based on the methodology discussed in Section C-1.
[2] Calculated from PERP Legacy System.

This evaluation used the following approach to estimate the potential health impacts for each of the portable regulatory amendment scenarios.

1) Staff first obtained ARB's emissions inventory data for historic and projected diesel PM emission rates for multiple years from all diesel PM sources for the South Coast Air Basin (Table G-9).
2) Next, staff scaled the emission rates based on each of the portable regulatory amendment scenarios compliance rates (Table G-10).
3) To compare these emission rates to ambient concentrations, the 2012 ambient air diesel concentration for the South Coast Air Basin was used as a baseline.[1]
4) Staff estimated the total basin-wide diesel PM cancer risk using the procedures outlined in the 2015 Office of Environmental Health Hazard Assessment (OEHHA) Guidance Manual (Table G-11).
5) Using the total basin-wide diesel PM cancer risk, staff scaled the risks for each of the portable regulatory amendment scenarios (Table G-13).

The information below contains more detailed descriptions of the data and data sources used in the evaluation.

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[1] South Coast AQMD http://www.aqmd.gov/home/library/air-quality-data-studies/health-studies/mates-iv 2015.

1. ARB Emissions Inventory Data

Registration data from the statewide PERP Data Management System (PERP DMS) and data from several ARB emissions inventories were combined to calculate and project the levels of diesel PM from all sources, including diesel PM from portable engines, for the South Coast Air Basin in the years of 2017, 2020, 2021, 2023, 2027, 2030, and 2031. These years were chosen based on State Implementation Plan (SIP) attainment dates.

The emissions inventory for diesel PM for South Coast Air Basin is based on stationary, area-wide, and mobile sources[2]. Data collected from ARB's emissions inventory for this risk evaluation can be found in Table G-9 and Table G-10.

In general, ARB inventories are based on:

- A reporting requirement, survey, or other detailed assessment of the population and activity of an emissions source.
- Statewide or regional reports of fuel usage to corroborate activity and determine a reasonable estimate for total combustion activities.
- Future year population projections of equipment and activity based on sales projections and average retirement rates.
- Reductions from adopted ARB programs wherever applicable, including the Truck and Bus Regulation[3], In-Use Regulation for Off-road Equipment[4], Cargo Handling Equipment[5], 1998 Railroad Memorandum of Mutual Understanding (MOU)[6], OGV Programs[7], and many more. These programs have differing requirements, which are reflected in the inventories. Some reflect accelerated turnover to newer equipment, others require particulate matter filters, and some impact engine time. Most control programs give a variety of the above options.
- Future year growth projections were based on industry specific surrogates. For example, ocean going vessel activity was based on the Freight Analysis Framework[8], while construction was based on housing starts and other economic indicators.

Table G-9 below shows the historic and projected basin-wide emission rates of diesel PM in tons per day (tpd) from all sources in the South Coast Air Basin.

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[2] Emission Inventory Activities, Air Resources Board (ARB). https://www.arb.ca.gov/ei/ei.htm
[3] Truck and Bus Regulation. ARB https://www.arb.ca.gov/msprog/onrdiesel/onrdiesel.htm
[4] In-Use Off-Road Regulation. ARB https://www.arb.ca.gov/msprog/ordiesel/ordiesel.htm
[5] Cargo Handling Equipment. ARB https://www.arb.ca.gov/ports/cargo/cargo.htm
[6] Memorandum of Mutual Understanding (MOU) (1998), ARB https://www.arb.ca.gov/msprog/offroad/loco/loco.htm
[7] Ocean-Going Vessels, ARB https://www.arb.ca.gov/ports/marinevess/ogv.htm
[8] Freight Analysis Framework: https://ops.fhwa.dot.gov/freight/freight_analysis/faf/

Table G-9: Historic and Projected Basin-Wide Diesel PM Emission Rates (tpd) from all Sources in the South Coast Air Basin for Selected Years[1,2,3]

	2012	2017	2020	2021	2023	2027	2030	2031
Diesel PM (tpd)	9.43	6.20	4.84	4.31	3.80	3.39	3.27	3.26

[1] Year 2012 was chosen to represent a year with existing historical data.
[2] Years 2017, 2020, 2021, 2023, 2027, 2030, and 2031 were chosen based on State Implementation Plan (SIP) attainment dates.
[3] Data are rounded to nearest one hundredth.

Table G-10 below shows the historic and projected basin-wide emission rates of diesel PM emitted from portable diesel engines under the scenarios defined in Section B.

Table G-10: Historic and Projected Basin-Wide Diesel PM Emission Rates (tpd) from Portable Diesel Engines in the South Coast Air Basin for Selected Years[1,2,3]

Rule Scenario	2012	2017	2020	2021	2023	2027	2030	2031
BAU	0.544	0.392	0.323	0.295	0.235	0.142	0.108	0.101
Proposed Regulatory Amendments	0.544	0.392	0.280	0.273	0.205	0.119	0.106	0.100
Alternative #1	0.544	0.392	0.290	0.281	0.218	0.140	0.110	0.104
Alternative #2	0.544	0.392	0.277	0.271	0.207	0.121	0.104	0.098

[1] Year 2012 was chosen to represent a year with existing historical data.
[2] Years 2017, 2020, 2021, 2023, 2027, 2030, and 2031 were chosen based on State Implementation Plan (SIP) attainment dates.
[3] Data are rounded to the nearest one thousandth.

2. The 2015 MATES-IV (MATES-IV) Report from South Coast AQMD

MATES-IV (2015) is a study conducted by the South Coast Air Quality Management District (AQMD) to monitor and evaluate air toxic contaminants, primarily focusing on those associated with carcinogenic risk, in the South Coast Air Basin. MATES-IV employed the Comprehensive Air Quality Model with Extensions (CAMx), enhanced with a reactive tracer modeling capability (RTRAC), as the dispersion and chemistry modeling platform used to simulate annual impacts of both gaseous and particulate toxic compounds in the South Coast Air Basin. CAMx RTRAC regional modeling was conducted using Weather Research Forecast (WRF), a mesoscale meteorological model, meteorological data and projected emissions data for 2012 to simulate annual average concentrations of 19 key compounds. Simulated annual average concentration data shows diesel PM contributed the greatest risk throughout the domain with an annual average concentration of 0.93 µg/m^3.

3. 2015 OEHHA Guidance Manual

In 2015, the Office of Environmental Health Hazard Assessment (OEHHA) adopted the *Air Toxics Hot Spots Program Risk Assessment Guidelines: The Guidance Manual for the Preparation of Health Risk Assessments* (OEHHA Guidance Manual). The OEHHA Guidance Manual incorporates updated risk assessment methodologies based on the

passage of the Children's Health Protection Act of 1999 that requires OEHHA to ensure infants and children are explicitly addressed when assessing risk. In the last decade, advances in science have shown that early-life exposures to air toxics contribute to an increased lifetime risk of developing cancer, or otherwise adverse health effects, compared to exposures that occur in adulthood. The new risk assessment methodology addresses this greater sensitivity and incorporates the most recent data on childhood and adult exposure to air toxics.[9]

Key changes addressed in the new risk methodology include: age sensitivity factors, daily breathing rates, exposure duration, fraction of time at home and spatial averaging options. The changes in the new risk methodology when compared to OEHHA's (prior) 2003 risk assessment methodology may result in a higher overall potential cancer risk estimate for the same source, even though emissions have not changed.[9]

While the OEHHA Guidance Manual was drafted to include these key changes, ARB simultaneously developed the HARP 2 Risk Assessment Standalone Tool (RAST) that can estimate health impacts from ground level concentrations. The program uses the new methodologies and algorithms identified in the OEHHA Guidance Manual to estimate all health risk results.

For this estimated cancer risk evaluation, HARP 2 RAST requires: an average concentration of the pollutant(s) being evaluated, the type of risk to assess (e.g., cancer risk), the type of receptor to evaluate (e.g., population-wide), the length of time exposed to the pollutant(s), the intake rate at which a person is exposed to the air pollutant(s) (i.e., how much a person breathes), and the pathway by which humans may be exposed to airborne chemicals (e.g., inhalation).

4. <u>Equations to Estimate Cancer Risk Associated with Portable Diesel Engines</u>

A series of calculations were used to find the portion of estimated cancer risk from all sources of diesel PM that can be attributed to diesel PM emitted from portable engines. The first equation produces a risk ratio by relating the estimated cancer risk to the total diesel PM for a past year where both cancer risk and basin-wide diesel PM are known. This risk ratio was then used to estimate future cancer risks from projected basin-wide diesel PM values. Next, the percentage of total basin-wide diesel PM emitted from portable engines was calculated for future years. Finally, the percent of basin-wide diesel PM emitted from portable engines was multiplied to the associated projected cancer risks from all diesel PM sources to find the projected cancer risk from diesel PM attributed to portable engines.

D. Health Risk Evaluation

In 1998, ARB identified Diesel Particulate Matter as a Toxic Air Contaminant (TAC) that can be attributed to non-cancer and cancer health effects. The current health values used in this evaluation can be found in the *Consolidated Table of OEHHA/ARB*

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[9] ARB/CAPCOA Risk Management Guidance: https://www.arb.ca.gov/toxics/rma/rmaguideline.htm

Approved Risk Assessment Health Values in Appendix L of the OEHHA Guidance Manual.

1. **Non-Cancer Risk Evaluation**

Non-cancer health effects can include asthma, increased respiratory symptoms, and decreased lung function, with developing children and the elderly being the most vulnerable.[10] A non-cancer chronic inhalation health impact estimate is calculated by dividing the annual average concentration by the Reference Exposure Level (REL)[11] of the air contaminant. This method results in a Hazard Quotient (HQ), shown in Equation 1 below:

$$Chronic\ Hazard\ Quotient = \frac{Annual\ Average\ Concentration\ \ \mu g/m^3}{Chronic\ REL\ \ \mu g/m^3} \qquad Eq.\ 1$$

The 2012 ambient air concentration from MATES-IV, 0.93 µg/m^3, and the REL of diesel PM, 5.0 µg/m^3, is used to find the HQ estimate in the South Coast Air Basin shown below.

$$Chronic\ Hazard\ Quotient\ for\ Diesel\ PM = \frac{0.93\ \ \mu g/m^3}{5.0\ \ \mu g/m^3}\ = 0.186$$

2. **Cancer Risk Evaluation**

The estimated cancer risk evaluation uses the OEHHA Guidance Manual risk methodology to project the basin-wide diesel PM cancer risk in the South Coast Air Basin. Cancer risk is expressed as the increased probability of a certain number of people developing cancer out of one million people within a designated geographic area.

This section explains the calculations used to evaluate the projected basin-wide total diesel PM cancer risk, the projected total diesel PM cancer risk, and the projected diesel PM cancer risk resulting from emissions from portable engines using the scenarios from Section B.

i. Basin-Wide Total Diesel PM Cancer Risk

Basin-wide cancer risk from diesel PM in the South Coast Air Basin is estimated by taking the population-weighted annual average concentration for diesel PM listed in MATES-IV, equal to 0.93 µg/m^3, and inputting it into HARP 2 RAST.

The following data was input into HARP 2 RAST v.17023 to estimate the basin-wide cancer risk from all diesel PM sources, which resulted in a potential cancer risk of 831 chances per million:

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[10] Air Resources Board *Overview: Diesel Exhaust and Health*:
https://www.arb.ca.gov/research/diesel/diesel-health.htm
[11] OEHHA Guidance Manual: https://oehha.ca.gov/air/air-toxics-hot-spots

- Concentration Level – 0.93 μg/m^3
- Analysis Type – Cancer Risk
- Receptor Type – Population-Wide
- Exposure Duration – 70-Year[12]
- Intake Rate Percentile – Risk Management Policy - Inhalation Only[13]
- Pathways to Evaluate – Inhalation

ii. Basin-Wide Historic and Projected Total Diesel PM Cancer Risk

The historic and projected basin-wide emission rates for diesel PM and the basin-wide risk from all diesel PM sources are used to estimate the cancer risk ratio, shown in Equation 2 below.

$$Risk\ Ratio = \frac{Cancer\ Risk\ (chances\ per\ million)}{Emission\ Rate\ (\frac{Tons}{Day})} \qquad Eq.\ 2$$

The 2012 emission rate data from Table G-9, equal to 9.43 tpd, and the basin-wide cancer risk from all diesel PM sources, estimated at 831 chances per million, is input into Equation 2 to calculate the risk ratio shown below.

$$Risk\ Ratio = \frac{831\ (chances\ per\ million)}{9.43\ (\frac{Tons}{Day})} = 88.12$$

The relationship between cancer risk and emission rates is linear; therefore, future potential cancer risk can be projected by multiplying the risk ratio of 88.12, calculated in Equation 2, to the projected basin-wide diesel PM emission rates for each year listed in Table G-9, as shown in Equation 3 below, to estimate the projected basin-wide cancer risk from diesel PM, italicized in Table G-11.

$$Projected\ Cancer\ Risk = Risk\ Ratio * Projected\ Emission\ Rate \qquad Eq.\ 3$$

For example, the calculation below shows the projected basin-wide diesel PM cancer risk for the South Coast Air Basin in 2017:

$$Basin\text{-}Wide\ Diesel\ PM\ Cancer\ Risk^{14} = 88.12 * 6.20\ tpd = 546\ chances\ per\ million$$

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[12] The current risk assessment methodology recommended in the *OEHHA Guidance Manual* and used by ARB staff in evaluating potential population-wide cancer risk is based upon an exposure duration of 70.25 years. This exposure duration assumes exposure from the last trimester of pregnancy to 70 years of age.

[13] The current risk assessment methodology recommended by the ARB/CAPCOA *Risk Management Guidance* includes age-specific breathing rates for children and adults.

[14] Estimated Cancer Risk from portable engines has been rounded to the nearest whole number.

Table G-11: Historic and Projected Basin-Wide Diesel PM Cancer Risk from all Sources in the South Coast Air Basin for Selected Years[1,2,3]

	2012	2017	2020	2021	2023	2027	2030	2031
Diesel PM (tpd)	**9.43**	6.20	4.84	4.31	3.80	3.39	3.27	3.26
Cancer Risk (chances per million)	**831**	*546*	*427*	*380*	*335*	*299*	*288*	*287*

[1] Year 2012 was chosen to represent a year with existing historical data.
[2] Years 2017, 2020, 2021, 2023, 2027, 2030, and 2031 were chosen based on State Implementation Plan (SIP) attainment dates.
[3] Data are rounded to the nearest whole number.

iii. Basin-Wide Historic and Projected Diesel PM Cancer Risk Resulting from Portable Diesel Engine Emissions

The cancer risks associated with diesel PM from all sources in the South Coast Air Basin, shown in Table G-11, can be used in conjunction with the ratio of diesel PM emitted from portable sources divided by the diesel PM emitted from all sources (including portable) to estimate the basin-wide cancer risk from portable diesel engines.

The ratio of diesel PM emitted from portable sources divided by the diesel PM emitted from all sources must be calculated for the selected years using Equation 4 below.

$$\frac{Annual\ diesel\ PM\ from\ Portable\ Under\ Chosen\ Scenario}{Annual\ diesel\ PM\ from\ all\ Sources} * 100\% = \%\ diesel\ PM\ from\ Portable \quad Eq.\ 4$$

For example, the percent of diesel PM from portable sources in 2017 under the BAU scenario is calculated below.

$$\frac{0.392\ tpd\ diesel\ PM}{6.20\ tpd\ diesel\ PM} * 100\% = 6.3\ \%\ diesel\ PM\ from\ Portable$$

Table G-12 shows the estimated annual basin-wide diesel PM from portable engines, the annual basin-wide diesel PM from all sources (including portable), and the percentage of total basin-wide diesel PM from portable sources.

Table G-12: Percentage of Basin-Wide Diesel PM Emitted From Portable Engines in the South Coast Air Basin[1,2,3]

Rule Scenario	2012	2017	2020	2021	2023	2027	2030	2031
Basin-Wide Diesel PM from all Sources (tpd)	*9.43*	*6.20*	*4.84*	*4.31*	*3.80*	*3.39*	*3.27*	*3.26*
BAU	0.544	0.392	0.323	0.295	0.235	0.142	0.108	0.101
% of Total Diesel PM	*5.8%*	*6.3%*	*6.7%*	*6.8%*	*6.2%*	*4.2%*	*3.3%*	*3.1%*
Proposed Regulatory Amendments	0.544	0.392	0.280	0.273	0.205	0.119	0.106	0.100
% of Total Diesel PM	*5.8%*	*6.3%*	*5.8%*	*6.3%*	*5.4%*	*3.5%*	*3.2%*	*3.1%*
Alternative #1	0.544	0.392	0.290	0.281	0.218	0.140	0.110	0.104
% of Total Diesel PM	*5.8%*	*6.3%*	*6.0%*	*6.5%*	*5.7%*	*4.1%*	*3.4%*	*3.2%*
Alternative #2	0.544	0.392	0.277	0.271	0.207	0.121	0.104	0.098
% of Total Diesel PM	*5.8%*	*6.3%*	*5.7%*	*6.3%*	*5.4%*	*3.6%*	*3.2%*	*3.0%*

[1] Year 2012 was chosen to represent a year with existing historical data.
[2] Years 2017, 2020, 2021, 2023, 2027, 2030, and 2031 were chosen based on State Implementation Plan (SIP) attainment dates.
[3] Data are rounded to the nearest one thousandth and percentages rounded to nearest tenth.

The proportion of estimated cancer risk that can be attributed to portable diesel engines under each scenario can be estimated by multiplying the projected basin-wide cancer risk from all diesel PM sources in Table G-11, with the percentage of total diesel PM that is emitted by portable engines under each scenario for each specified year calculated in Table G-12.

Cancer Risk from Portable = Basin-wide diesel PM from all Sources* % diesel PM from Portable Engines   Eq. 5

For example, Equation 5 shows how to calculate the cancer risk from portable diesel engines under the *BAU Scenario* in 2017:

Cancer Risk from Portable[15]= 546 chances per million* 6.3%= 35 chances per million

Applying this formula to all scenarios for all years, results in the estimated cancer risks attributed to portable diesel engines shown in Table G-13.

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[15] Estimated Cancer Risk from portable engines has been rounded to the nearest whole number.

Table G-13: Historic and Projected South Coast Basin-Wide Cancer Risks (Chances per Million) from Portable Diesel Engines for Selected Years[1,2,3]

Rule Scenario	2012	2017	2020	2021	2023	2027	2030	2031
All Diesel PM Sources	831	546	427	380	335	299	288	287
BAU	48	35	29	26	21	13	10	9
Proposed Regulatory Amendments	48	35	25	24	18	11	9	9
Alternative #1	48	35	26	25	19	12	10	9
Alternative #2	48	35	24	24	18	11	9	9

[1] Year 2012 was chosen to represent a year with existing historical data.
[2] Years 2017, 2020, 2021, 2023, 2027, 2030, and 2031 were chosen based on State Implementation Plan (SIP) attainment dates.
[3] Data are rounded to the nearest whole number.

E. Key Findings

This health risk estimate evaluated both non-cancer and cancer risk from diesel PM emissions in relation to the South Coast Air Basin as a reasonable representation of statewide diesel PM emissions.

For a non-cancer inhalation risk evaluation a HQ of 1.0 or less indicates that adverse health effects are not expected to result from exposure to emissions of that substance (*OEHHA Guidance Manual*). The South Coast Air Basin non-cancer inhalation Hazard Quotient (HQ) is 0.186. The calculated HQ in this assessment falls below the OEHHA recommended value, as well as below the South Coast AQMD permitting threshold of 1.0.[16]

The results of the projected cancer risk attributed to portable engine diesel PM emissions are tabulated in Table G-13 and presented graphically in Figure 1 below.

All scenarios have a projected cancer risk of 9 chances per million by 2031 in the South Coast Air Basin. However, results show the Proposed Regulatory Amendments, Alternative #1 and Alternative #2 consistently have a lower projected cancer risk starting in 2020 compared to the BAU scenario.

The BAU has the strictest standards in reducing diesel PM emissions within the smallest timeframe, but it also has the highest estimated cancer risk. This is due to industry being unable to comply with the set standards because of the unanticipated high cost and delay in availability of newer, cleaner tiered engines and the low degree of feasibility of Verified Diesel Emission Control Strategies (VDECS) in the application of portable diesel engines.

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[16] ARB/CAPCOA *Risk Management Guidance*: https://www.arb.ca.gov/toxics/rma/rmaguideline.htm

The Proposed Regulatory Amendments and Alternative #2 achieve the lowest level of projected cancer risk when compared to Alternative #1 for the years selected. However, the earlier fleet standards and stricter 2025 phase-out schedule used in Alternative #2, compared to the Proposed Regulatory Amendments, would be a more costly alternative to businesses.

The Proposed Regulatory Amendments are a more enforceable and achievable scenario that provides relief from the current ATCM and results in higher compliance rates with a net decrease in emissions when compared to the BAU. This would result in a reduction of potential cancer risk associated with portable diesel PM engine emissions earlier than the BAU scenario in the South Coast Air Basin as seen in Table G-13 and Figure 1.

Using the earlier assumption that the South Coast Air Basin would represent an upper bound estimation of the risks statewide, it is reasonable to conclude that the potential cancer risk associated with portable diesel PM engine emissions under the Proposed Regulatory Amendments would also achieve an earlier potential cancer risk reduction statewide compared to the BAU scenario.

Figure 1: South Coast Basin-Wide Cancer Risks from Portable Engines under Multiple Rule Scenarios[1,2]
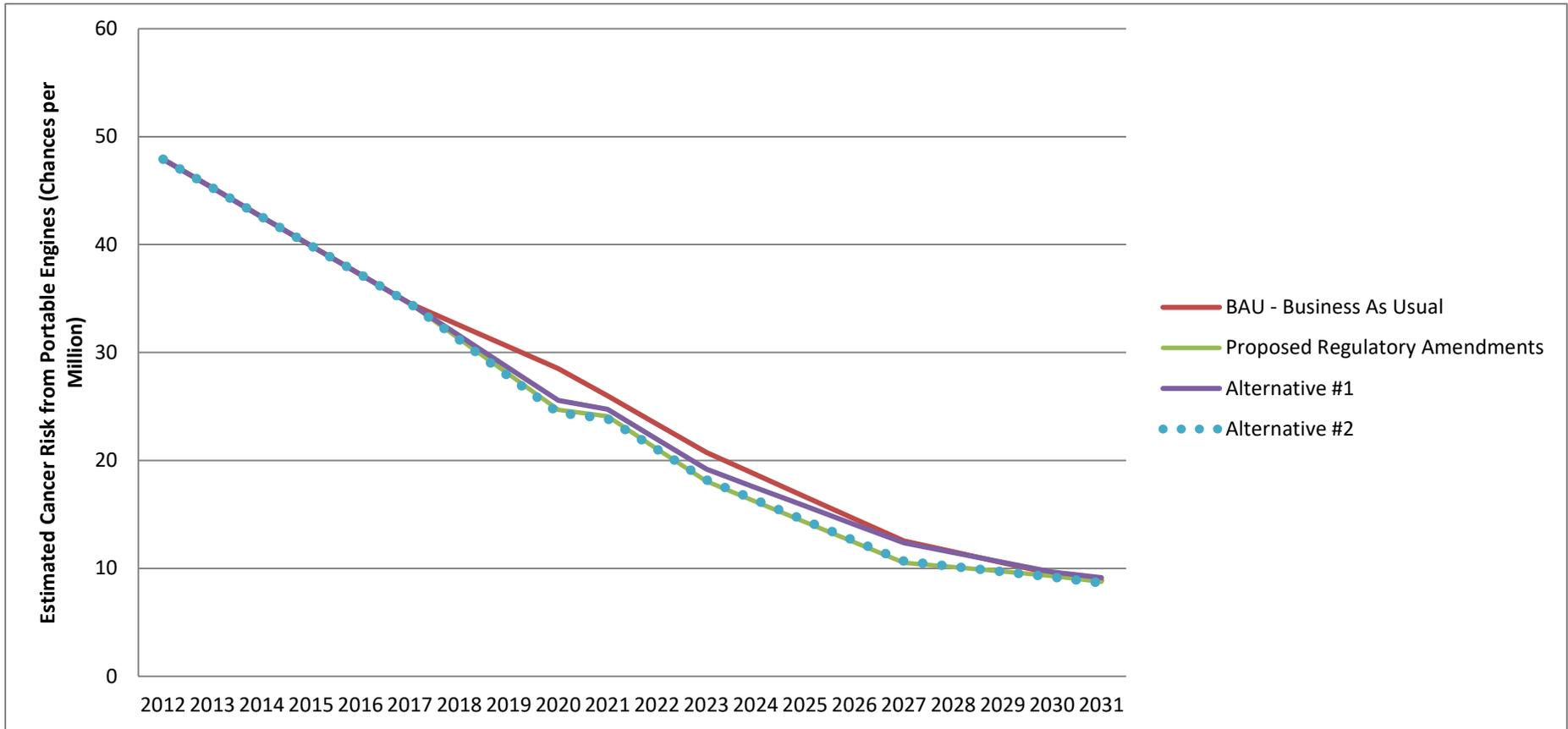
[1] Data only provided for Years 2017, 2020, 2021, 2023, 2027, 2030, and 2031; therefore, a linear decrease between the years was assumed.

[2] Portable Regulatory Amendments and Alternative #2 have the same emission reduction standards; however, Alternative #2 has an earlier phase-out date of 2025. The graph shows the Proposed Regulatory Amendments and Alternative #2 lines overlapping (appears as a single green line) and reaching the same potential cancer risk in 2027. The assumption of a linear decrease between the years does not reflect Alternative #2 reaching 11 chances per million two years earlier than the Proposed Regulatory Amendments, in Year 2025.

References

The following documents are the technical, theoretical, or empirical studies, reports, or similar documents relied upon in proposing these regulatory amendments, identified as required by Government Code, section 11346.2, subdivision (b)(3).

1. *Overview: Diesel Exhaust and Health*. California Air Resources Board. https://www.arb.ca.gov/research/diesel/diesel-health.htm April 2016

2. *Risk Management Guidance for Stationary Sources of Air Toxics.* California Air Resources Board and California Air Pollution Control Officers Association. https://www.arb.ca.gov/toxics/rma/rmaguideline.htm July 2015

3. *The Guidance Manual for the Preparation of Health Risk Assessments*. Office of Environmental Health Hazard Assessment, California Environmental Protection Agency, Air Toxics Hot Spots Program Risk Assessment Guidelines. https://oehha.ca.gov/air/air-toxics-hot-spots February 2015.

4. *Multiple Air Toxics Exposure Study IV (MATES IV)*. South Coast Air Quality Management District. http://www.aqmd.gov/home/library/air-quality-data-studies/health-studies/mates-iv May 2015