Appendix C

Standardized Regulatory Impact Assessments

(SRIA)

State of California
AIR RESOURCES BOARD

Proposed Portable Equipment Regulation and Airborne Toxic Control Measure Amendments

Appendix C-1

March 2017 Standardized Regulatory Impact Assessment

and

Appendix C-2

REVISED Standardized Regulatory Impact Assessment

(SRIA)

Air Resources Board
1001 I Street
Sacramento, California 95814

Appendix C-1
Proposed Portable Equipment Regulation and ATCM Amendments
Standardized Regulatory Impact Assessment (SRIA)
Submitted to the Department of Finance March 2017

A. Summary

The Portable Engine Airborne Toxic Control Measure (ATCM) is a regulation adopted in 2004 that set emissions requirements for portable engines to reduce exposure to toxic diesel particulate matter (PM) and protect public health. The ATCM works in concert with the Portable Equipment Registration Program (PERP) 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. This increased the cost to regulated parties compared to the estimates at the time of ATCM adoption. The purpose of the proposed amendments to the PERP and ATCM (together referred to as Portable Regulatory Amendments) is 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. The emission levels required under the current ATCM in 2020 will still be achieved, but will be delayed by seven years as demonstrated in Figures 1 and 2 (Section B. Non-Monetary Impacts).

Portable engines (and associated equipment) and non-combustion equipment units are regulated by the California Air Resources Board (ARB) and by the 35 local air districts in California. Examples of portable engines include those used in well drilling, service or work-over rigs, power generation (excluding cogeneration), pumps, compressors, diesel pile-driving hammers, welding, cranes, wood chippers, dredges, and military tactical support equipment applications. Equipment units are pieces of portable equipment that emit non-combustion related particulate matter less than 10 microns in diameter (PM10) and are used in activities that include, but are not limited to, confined and unconfined abrasive blasting, concrete batch plants, sand and gravel screening, rock crushing, and unheated pavement recycling and crushing. Permitting requirements for portable engines and equipment units vary among the air districts.

In 1995, the California legislature mandated that ARB establish a fee-based, voluntary, uniform, and statewide registration program for portable equipment. This statewide program would provide an alternative path to registration to portable equipment owners that operate in multiple air districts. Absent a uniform statewide program, equipment owners must obtain an operating permit from each air district in which the engine or equipment unit operates, potentially leading to multiple permits for one piece of equipment. As a result of the California legislature's mandate, ARB adopted the PERP regulation in 1997, which defined the

equipment allowed to register in PERP, set operational limits for registered equipment, established registration procedures, and set registration fees. A portion of the registration fees is distributed to the local air districts that perform inspections and enforce the operational conditions of PERP registrations.

ARB adopted the ATCM in 2004 as part of a broad initiative, called the Diesel Risk Reduction Plan, to control diesel particulate emissions from many diesel engines and equipment to protect public health. The ATCM prohibits operating older portable engines that emit higher levels of air pollutants than newer engines, sets strict engine eligibility for portable engines registering in PERP, limits districts to permitting only engines certified to meet federal emission standards, and requires all fleets to meet fleet emission standards.

When ARB adopted the ATCM in 2004 the rulemaking relied on several assumptions about developing new technologies as the basis for establishing stringent fleet emission standards. The costs presumed an abundance of Tier 4 engines would be available for fleet owners to purchase at competitive prices and that these purchases could be made well before the emissions standards were required. The rulemaking also assumed that where Tier 4 engines were not yet available, engines could be retrofit to comply with the standards. In reality, the costs were much higher than anticipated, Tier 4 engines were not available as early as anticipated, and retrofits were not available for all engine categories.

1. Statement of the Need of the Portable Regulatory Amendments

a) Goal of the Portable Regulatory Amendments

The goal of the PERP and ATCM is to provide diesel particulate matter (PM) emissions reductions to protect public health. Because the original rules assumed emissions control technologies would come to market more quickly than they did, compliance costs are compressed, resulting in extremely high annual costs. The goal of the Portable Regulatory Amendments is to extend the time frame of compliance such that fleets can achieve fleet standards to reduce toxic air emission as envisioned in the original PERP and ATCM regulations, though at a later date. To accomplish this goal, and ensure that the 1995 legislative mandates are achieved, the Portable Regulatory Amendments:

- Maintain a uniform statewide registration program for portable equipment,
- Simplify fleet emission requirements for small fleets,
- Recognize and reward fleet owners that made early investments to comply with the 2017 ATCM fleet requirements, and
- Provide incentives, where possible, for early compliance.

b) Statement of Need for the Portable Regulatory Amendments

This section contains a brief discussion outlining the need for the Portable Regulatory Amendments, while a more extensive description will be presented in the Initial Statement of Reasons.

At the time of the 2004 ATCM adoption, it was assumed that equipment owners would comply using a combination of the following compliance options: replacement of retired equipment with new, compliant equipment; retrofit of existing engines, particularly those with several years of useful life, with after-treatment devices; or repower existing equipment by replacing retired engines with new, compliant engines. In reality, deployment of Tier 4 engines in the portable equipment market was delayed, retrofits were not made widely available for portable use, and repower was technologically not possible in most cases due to a significantly larger footprint of new engines. Fleets are now in the position to replace both the engine and the equipment simultaneously in order to achieve compliance, and must replace both in a compressed timeframe compared to timeline envisioned under the 2004 ATCM regulation. Due to delayed availability into the portable market, fleets are required to replace about 90 percent of their equipment with new equipment housing Tier 4 engines by 2020.

In the 2004 Portable Engine ATCM Initial Statement of Reasons, ARB compliance assumptions relied on new emissions control devices, known as Verified Diesel Emission Control Strategies (VDECS), becoming available for portable engines to meet the ATCM standards in 2017.[1] VDECS were expected to provide a cost-effective emissions control retrofit option for older engines. Manufacturers of VDECS found diesel particulate filters difficult to manufacture and certify for the portable sector due to: the large number of different applications (chippers, generators, pumps, compressors, crushers, etc.); the number of different engine manufacturers and models; the varying duty cycles of each application; and the economic uncertainty of entering a relatively small and diverse market. Therefore, VDECS did not make their way to the portable engine sector as expected. This fact is demonstrated through analysis of PERP engine registration data. To date, only 7 of 30,000 registered engines have been retrofitted with emission control devices.

Portable equipment includes expensive machines meant to be operated for decades after purchase. The current ATCM assumes older machines could be repowered with compliant engines to meet regulatory requirements. The idea behind repowering was that an older tier engine would be simply removed from its existing chassis and a newer tiered engine would be placed in its existing configuration. However, repowering existing equipment with Tier 4 technology is not possible because Tier 4 engines are much larger in size per horsepower than older engines due to the emission control technologies required to comply with Tier 4 emission standards. This size difference was not envisioned in 2004, since the compliant engine technology had not yet been developed. Equipment owners have found it necessary to purchase entire new pieces of portable equipment equipped with new engines to comply with the current rule. It is possible that many fleets would need to turnover 90 percent of their existing equipment by 2020 in order to meet the current standards, a timeframe that has been deemed unrealistic by many fleet owners, as short-term financing options are limited and can result in extremely high compliance costs.

The ATCM also assumed that fleets would comply in part by purchasing compliant equipment housing Tier 4 engines. Staff anticipated the first Tier 4 engines would be available on June 30, 2011, six months after the interim Tier 4 certification standard became effective for 175 and greater horsepower engines. In reality, the availability of Tier 4 engines was delayed by at

[1]https://www.arb.ca.gov/regact/porteng/isor.pdf

least a year. Equipment manufacturers experienced delays receiving the test engines and once received found the engines to be larger than previous engine generations. The larger engines forced redesign of the equipment chassis to accommodate the larger Tier 4 footprint, which caused further delay in the availability of compliant equipment to the market and led to a doubling of the cost of new equipment with Tier 4 compliant engines. To address these issues, ARB extended the six-month eligibility of the previous tier engines to 18 months after each subsequent Tier 4 certification went into effect under the compliance flexibility provisions of the ATCM. However this flexibility is not sufficient to fully address the delay in engine availability.

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,[2] contains provisions which allow equipment manufacturers to sell up to 80 percent of their equipment with engines certified to the previous tier after a new tier requirement becomes effective. The engines produced under these provisions are known as flex engines. Because of the flex provisions, a large volume of flex engines were produced and flooded the portable engine market, particularly Tier 3 flex engines rated less than or equal to 750 brake horsepower and Tier 2 flex engines rated greater than 750 brake horsepower. Flex engines have higher emissions rates than Tier 4, and alone do not meet the 2017 or 2020 ATCM emissions for most engine horsepower categories. Because engine manufacturers could legally produce flex engines (under the TPEM), they produced Tier 3 category engines. These engines were integrated into portable equipment because of the high cost of re-engineering low sales volume equipment with larger footprint tier 4 engines. As fleets needed to purchase new equipment in accordance with their normal turnover schedules, many purchased the Tier 3 flex engines available under the TPEM because Tier 4 engines were not readily available. Unfortunately, new Tier 3 flex engines did not drive down fleet diesel PM emissions to the degree necessary to comply with the 2017 fleet standards. In many cases, meeting the current 2017 ATCM standards would require fleets that purchased Tier 3 flex engines to replace them after only three to five years of use (when the expected service life of the equipment is at least 20 years).

In summary, retrofit technologies and repower options, which represent the most cost-effective compliance options to meet ATCM requirements, have not developed as anticipated in the 2004 ATCM. To meet regulatory requirements, fleets must purchase new equipment with Tier 4 engines installed, which is much more costly. The higher than anticipated costs would occur over a more condensed time frame than originally anticipated and could require capital investments and loans that would be difficult for fleets to secure in the necessary timeframe. Specific cost comparisons are discussed in the next section. The result is only 10 percent of fleets are likely to meet regulatory requirements by 2020. Based on stakeholder discussions, meeting the 2004 ATCM requirements would result in significant cost burdens to fleets. While we cannot predict the fleet response to these high costs, stakeholders suggest it could lead to significant increases in consumer prices and potentially drive fleets to exit the California market, specifically small businesses. However, stakeholders believe that distributing the costs over the longer timeframe proposed in the Portable Regulatory Amendments will alleviate the

[2] 40 CFR 1039.625, https://www.gpo.gov/fdsys/granule/CFR-2014-title40-vol33/CFR-2014-title40-vol33-sec1039-625

concerns regarding compliance costs and timing. The Portable Regulatory Amendments will also achieve the emission levels required under the current ATCM in 2020 with a delay of seven years.

2. Identification of the Baseline (Referred to as Business As Usual)

The business as usual scenario (BAU) used as a baseline for this economic analysis assumes the current ATCM is fully enforced and all fleets meet existing fleet average standards to control the diesel particulates they emit. Costs (or cost-savings) of the Portable Regulatory Amendments are calculated relative to this baseline.

ARB performed an engineering analysis to estimate the composition of the fleet in the BAU scenario by tabulating the non-road diesel engine emission standards for Tiers 1, 2, 3, and 4 under 40 CFR 89.102[3] and 40 CFR 1039.102[4] and the 2017 and 2020 fleet standards for the existing ATCM shown in Table 3. Equation 1 below was used to calculate what percent of a fleet must be Tier 4 to be compliant with each fleet standard.

$$x = \frac{standard - (Tier\ 1\ or\ 2\ or\ 3\ standard)}{Tier\ 4\ std - (Tier\ 1\ or\ 2\ or\ 3\ standard)} \qquad Eq.1$$

Where *x* is the percent of Tier 4 engines required for a fleet to be compliant with an ATCM standard for a certain percent of Tier 1, 2, or 3 engines.

$$y = 1 - x \qquad Eq.2$$

The variable *y* in Equation 2 shows what percent of that same fleet must be Tier 1, Tier 2, or Tier 3, depending on which Tier standard is used. For example, to calculate what percent Tier 4s and Tier 2s would be required to meet the 2017 standard for engines 175-750 horsepower, *standard* = 0.08, *Tier 2 standard* = 0.15, and *Tier 4 standard* = 0.01 which yields *x*=50 percent, or 50 percent of the fleet must be Tier 4 for fleet to comply with the 0.08 standard. This equation was used for each Tier standard and each ATCM fleet standard for each horsepower category then averaged to calculate the average fleet compositions above.

Because retrofit and repower are not feasible compliance options, equipment replacement is the only viable option for operators to reduce their fleet average emissions. Equipment replacement is the highest cost compliance option and was never intended to be the sole compliance option to meet regulatory requirements.

The cost to comply with the current 2004 ATCM (the cost of the BAU in this analysis) was analyzed to reflect updated data not available at the time of the original adoption of the regulation. The new projected equipment replacement cost used to characterize the BAU is split into two horsepower categories because data analysis suggested a significant difference in costs between the two horsepower ranges. For engines in the 50 to 175 horsepower range the modeled cost is between $100 and $450 per horsepower. For engines greater than 175

[3] 40 CFR 89.102, https://www.law.cornell.edu/cfr/text/40/89.102
[4] 40 CFR 1039.102, https://www.law.cornell.edu/cfr/text/40/1039.102

horsepower the modeled cost for engines is between $100 and $300 per horsepower. These cost model inputs are discussed in further detail in the Direct Cost section (D).

3. Major Regulation Determination

The Portable Regulatory Amendments are a major regulation because the estimated direct cost savings of the proposal exceeds $50 million within a 12-month period after full implementation. Postponing the turnover of older tiered engines, as proposed in the Portable Regulatory Amendments, would result in direct cost savings to all fleets registered in PERP of over $60 million every year through 2024 in response to delayed purchase requirements. The direct cost savings are explained in more detail in the Direct Cost section (D) of this document.

4. Public Outreach and Input

The Portable Regulatory Amendments have been developed through a robust public process involving government and industry stakeholders. ARB solicited participation from CAPCOA (California Air Pollution Control Officers Association), which is the association of air pollution control officers from all 35 local air quality agencies located throughout California. To support the development of the Portable Regulatory Amendments, CAPCOA formed a subcommittee of seven CAPCOA member districts which actively participated in the regulatory development process. ARB also participated in separate meetings with the California Department of Transportation (CalTrans) which has a large fleet of portable engines registered in PERP and was concerned about meeting the 2017 fleet requirements.

ARB conducted eight public workshops on the Portable Regulatory Amendments. The workshops included affected industry stakeholders, members of the CAPCOA subcommittee, and the public. The workshops were held throughout the state on March 3, March 8, March 10, June 30, September 13, September 15, September 20, and November 10, 2016. Workshops were webcast to encourage participation by stakeholders who could not attend in person. Following each workshop, and throughout the regulatory development process, ARB received input from and worked with stakeholders on a variety of changes in the Portable Regulatory Amendments. Announcements and materials related to the workshops were publically posted on the ARB website[5] and distributed through a list serve[6] to over 14,000 recipients.

At the first series of workshops in March, ARB invited the public to join a workgroup of interested stakeholders that would help shape the Portable Regulatory Amendments. The resulting workgroup consisted of 48 industry representatives and CAPCOA subcommittee members. ARB held five formal workgroup meetings and many smaller meetings at the request of individual workgroup members. The five Workgroup meetings were conducted on April 19, May 4, June 9, August 17, and October 26, 2016. The Portable Regulatory Amendments, including alternatives, were directly shaped by stakeholder comments and suggestions.

[5] https://www.arb.ca.gov/portable/perpact/portable-activity.htm
[6] https://www.arb.ca.gov/listserv/listserv_ind.php?listname=portable

5. Description of the Portable Regulatory Amendments

The Portable Regulatory Amendments contains requirements for fleets based on each individual fleet's cumulative horsepower. Small fleets will be those with less than or equal to 750 total combined horsepower. They will be required to follow a tier phase-out schedule, where specific lower-tiered engines must be removed from service by certain years. The small fleet tier phase-out schedule will provide additional time to meet regulatory requirements compared to the existing PERP and ATCM regulations and allow for automatic compliance management through the PERP registration process. This approach not only reduces compliance costs for small fleets as compared with the original rule, but also simplifies implementation and enforcement.

Large fleets are those that exceed 750 total combined break horsepower (bhp). Large fleets will have the option to follow a tier phase-out schedule or comply with a set of fleet average standards. Proposed fleet average standards would require an average fleet composition of 90 percent Tier 4 and 10 percent Tier 1, 2, or 3 engines by 2027. The Portable Regulatory Amendments represent a seven-year delay in equipment phase-out relative to the current regulation. The Portable Regulatory Amendments would thus spread out compliance costs over an additional seven years, while still achieving emissions reductions and technology goals when the Portable Regulatory Amendments are fully implemented.

The established tier phase-out schedule for all fleets requires a complete turnover to Tier 4 engines by 2029 with the exception of flex engines, as shown in Table 1. Large fleets will also have the option of meeting fleet average emissions standards instead of tier phase-out requirements. Proposed fleet average emissions standards in grams per brake horsepower hour (g/bhp-hr) are shown in Table 2, and can be compared to current fleet average requirements in Table 3.

Table 1: Proposed Engine Tier Phase-Out Schedule

	Engines rated 50 to 750 bhp		
	Large Fleet	***Small Fleet***	
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	NA
Tier 3 built on or after 1/1/2009	1/1/2027	1/1/2029	NA
Flexibility engines (Tier 1,2, and 3)	December 31 of the year 17 years after the date of manufacture		

Table 2: Proposed Fleet Average Option for Large Fleets

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

Table 3: 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

B. Non-Monetary Impacts

The primary change that arises from the Portable Regulatory Amendments is the proposed change to the fleet requirements. The main change that results from the Portable Regulatory Amendments is a delay in fleet emissions standards which delays the removal of older engines from the fleet. These older engines, with higher PM and NOx emissions compared to newer Tier 4 engines, will remain in operation longer than originally allowed under the current regulation (the BAU in this economic analysis). The addition of a tier phase-out schedule will promote greater compliance with the ATCM and PERP engine standards and will lead to the emission reductions envisioned by this 2004 ATCM regulation over an elongated timeframe. As explained above, ARB staff determined the existing fleet standards are financially and technologically unrealistic, primarily due to the lack of verified retrofits and the delayed availability and high cost of Tier 4 engines. Comparing the anticipated reductions that would have been achieved under the current standards in 2020, identified as the BAU, we see an overall delay of seven years in the rate of achieving PM and NOx reductions shown on Figures 1 and 2 below. Adoption of the proposed Portable Regulatory Amendments does not cause any degradation to current air quality, only a delay in the accrual of projected air quality benefits for the near term. Eventually the Portable Regulatory Amendments achieve the same reductions originally expected the ATCM and PERP regulations.

ARB calculated the change in the rate of emission reductions (in tons per day or tpd) caused by the change in compliance schedules. ARB estimates a delay of the original rate of emission reductions by seven years. ARB calculated and compared the projected emission reductions for 2020 and 2023 under the BAU to the projected emission reductions under the Portable Regulatory Amendments for the same two years. In 2020, ARB estimates fewer emission reductions by 0.38 tpd of PM and 9.0 tpd of NOx under the Portable Regulatory

Amendments compared to what was projected for 2020 under the BAU. In the key year of 2023 for attaining the National Ambient Air Quality Standard (NAAQS) for ozone in the South Coast air basin, ARB estimates fewer emission reductions by 0.14 tpd of PM and 3.8 tpd of NOx, which is a contributor to ozone formation, compared to the BAU. By 2027 the Portable Regulatory Amendments will achieve the same tons per day of emissions reductions as projected for the BAU. This will work to achieve the ozone NAAQS as initially projected in the 2004 ATCM regulation.

To illustrate this change in rates of emission reductions, Figures 1 and 2 plot the emission reductions of NOx and PM from portable engines under both the BAU and Portable Regulatory Amendments. If the existing ATCM standards are implemented, the fleet would turn over more quickly and emissions would decline faster than under the Portable Regulatory Amendments. In 2027, the rates of emission reductions under the Portable Regulatory Amendments catch up to rate of reductions under the BAU, shown by the blue and red lines converging.

Figure 1: Annual Statewide PM (tpd)

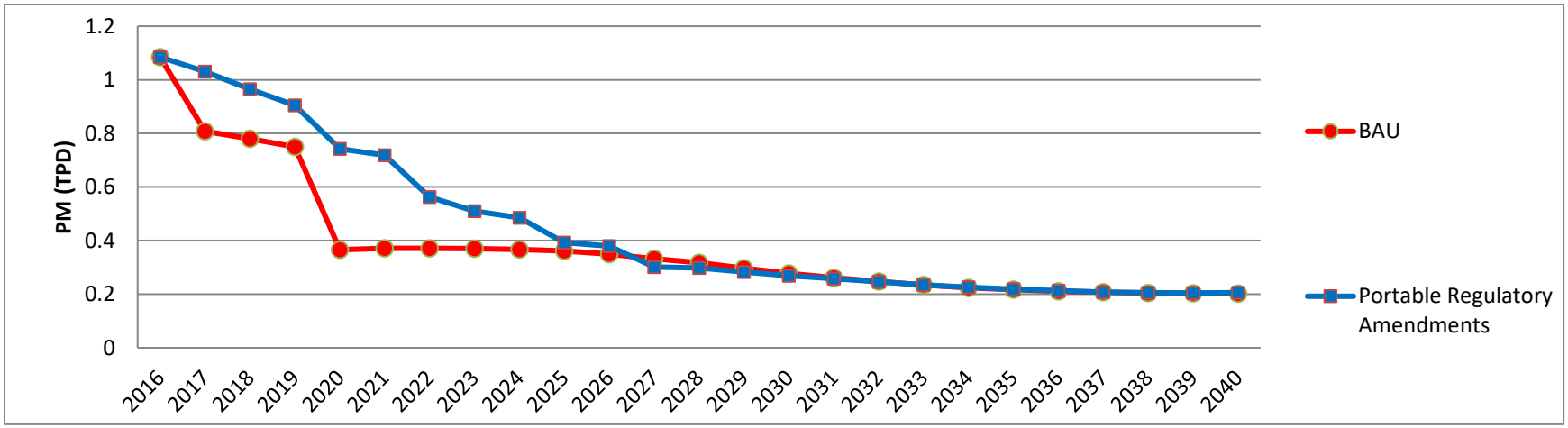
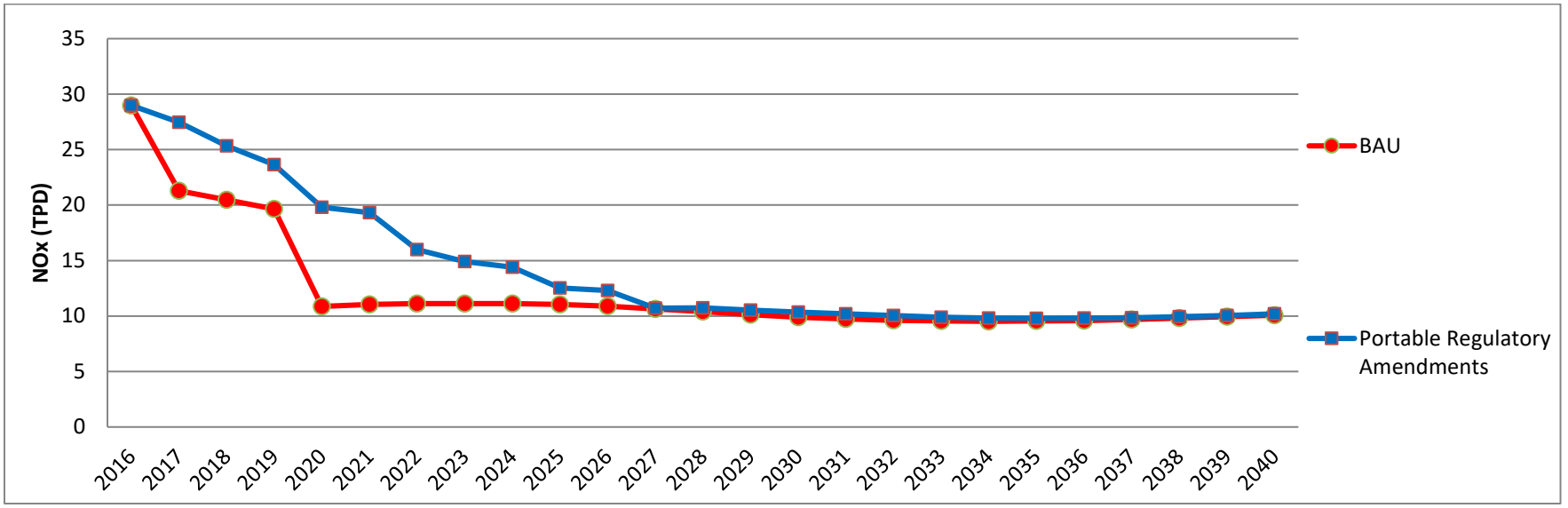


Figure 2: Annual Statewide NOx (tpd)



To estimate the potential health risk associated with the delay in emissions reductions under the Portable Regulatory Amendments, ARB estimated the cancer risk from the diesel PM emissions of portable equipment. This was determined by identifying the cancer risk from ambient concentrations of diesel PM multiplied by the proportion of diesel PM that can be attributed to portable engines. Most major sources of diesel PM emissions are often located near highly populated areas. Because of this, elevated PM levels are mainly an urban problem, with large numbers of people exposed to higher PM concentrations, resulting in greater health consequences compared to rural areas. The South Coast Air Basin has the greatest number of diesel PM sources and, therefore, represents an upper bound to the potential cancer risk state-wide. Table 4 outlines the cancer risk associated with estimated PM emissions from portable equipment in the South Coast Air Basin under the current regulation (or BAU), based on the rate of emissions projected when the regulation was adopted and the projected emissions from the Portable Regulatory Amendments over time.

Table 4. Projected South Coast Air Basin-Wide Cancer Risk from Portable Equipment Diesel PM (Chances per Million)

Year	BAU	Portable Regulatory Amendments
2012	48	48
2017	28	35
2020	13	25
2021	13	24
2023	13	18
2027	11	11
2030	10	9
2031	9	9

Table 4 shows that the projected exposure rate and associated cancer risk from portable equipment under the current regulation (or BAU) and the Portable Regulatory Amendments. The rates of exposure and cancer risk under these two scenarios will converge in 2027. However, there is a slightly higher remaining rate of exposure and associated elevated cancer risk from 2017 through 2027 under the projections for the Portable Regulatory Amendments compared to the projected rate of exposure for the current regulation. To put the excess cancer risk in perspective, a recent study found

the basin-wide cancer risk in Southern California from all sources to be 897 cases per million people.[7]

[7] http://www.aqmd.gov/docs/default-source/air-quality/air-toxic-studies/mates-iv/mates-iv-final-draft-report-4-1-15.pdf?sfvrsn=7; page ES-3

C. Benefits

The Portable Regulatory Amendments benefit regulated businesses by spreading out compliance costs and rewarding fleets that were able to make the investments necessary to meet current regulatory requirements.

1. Benefits to Individuals

There are no direct benefits to individuals as a result of the Portable Regulatory Amendments. Any indirect or induced impacts will be discussed in the Macroeconomic Impact section.

2. Benefits to Typical Businesses and Small Businesses

The Portable Regulatory Amendments directly benefit a wide-range of businesses that vary in size, revenue, and type of equipment such as rental companies, construction businesses, landscaping companies, and government agencies. For example, landscaping companies register portable engines that power wood processing equipment such as chippers and grinders. Construction companies register engines that power generators, compressors, pumps, pavement grinders, and conveyors. PERP registered engines that power compressors, generators, chippers, pumps are also owned by various government agencies and municipalities including county, city, state and federal departments. Some of these agencies include local sanitation departments, water districts, state prisons, universities, the United States military and many more. The Portable Regulatory Amendments provide economic relief to all regulated fleets by spreading out costs and providing the time to finance fleet upgrades to meet regulatory requirements.

While 78 percent of all portable fleets are classified as small fleets in the current regulation, these fleets represent only about 10 percent of total horsepower and emissions from all PERP equipment. The Portable Regulatory Amendments provide these 3,000 small fleets additional time to meet requirements, and the tier phase-out requirements in the Portable Regulatory Amendments greatly simplify fleet management and therefore reduce compliance costs for implementation.

The cost-savings will be discussed in more detail under the Direct Costs section, while additional discussion of the indirect and induced impacts on businesses will be discussed in the Macroeconomic Impact section.

D. Direct Costs

This section begins with the identification of the entities that are directly affected by the Portable Regulatory Amendments. Next, the methodology for estimating direct cost is outlined, including a discussion of the underlying assumptions.

1. Direct Costs on Individuals

There are no direct costs to individuals as a result of the Portable Regulatory Amendments. Any indirect or induced impacts on individuals will be discussed further in the Macroeconomic Impact section.

2. Direct Costs on Typical Businesses and Small Businesses

For most years under the Portable Regulatory Amendments, as compared with the BAU, fleets see an increase in registration fees, decreases in equipment and engines replacement costs, and decreases in costs for the diesel exhaust fluid (DEF) used to reduce emissions on Tier 4 engines. The largest direct costs to businesses are engine and equipment replacement costs. Direct costs and cost-savings to businesses are calculated on a fleet-by-fleet basis.

The engine and equipment replacement costs to businesses are calculated by projecting annual fleet engine purchases under the Portable Regulatory Amendments and taking the difference of those expenditures relative to the engine expenditures anticipated in the BAU. Engine and equipment expenditures are estimated using an equipment turnover model which simulates fleet-level annual engine and equipment purchases. The model relies on reported PERP data (discussed in Sections (a)(iii) and (a)(iv)) to estimate fleet purchasing habits and compliance requirements. A cost is assigned to each newly purchased engine and a residual value is assigned to each retired engine. With these values the model calculates the cost of engine and equipment replacement for each fleet in each calendar year. These costs are then amortized over a 5-year period at an 8 percent interest rate based on stakeholder feedback of typical financing conditions. Registration fees and DEF costs are added to calculate the total costs on businesses.

a. Inputs

The inputs to the direct cost estimation are outlined in the following section.

i. Equipment Cost

Equipment replacement represents the majority of costs of the Portable Regulatory Amendments. The equipment cost is the dollar value of a portable engine and its equipment package sold in the open market for engines of various tier, horsepower, age, and equipment type. During the Portable Regulatory Amendments process, ARB collected data on recently sold or listed for sale new and used portable equipment using cost data for equipment provided by stakeholders, as well as a variety of online sources. A cost curve was developed based on data from more than 230 pieces of portable equipment equipped with various engine tiers, horsepower, and age, representing generators, compressors, and pumps. The cost curve was then used in ARB's equipment turnover model to calculate equipment replacement cost on a per unit basis by taking the cost of newly purchased equipment required and subtracting it from the existing equipment's resale value.

ii. Fleet Compliance Path Selection

To determine the compliance path chosen by large fleets (either tier phase-out or fleet averaging), individual fleets were evaluated on the characteristics of the engines in their fleet. Fleets with one or more engine at least twelve years old and with a relatively low fleet emission average are predicted to follow the fleet average schedule. A low fleet emission average already puts these fleets on track to comply with the first fleet average standard in 2020 while allowing these large fleets the ability to retain older, potentially specialized, pieces of equipment that cannot be replaced due to technological or economic constraints.

ARB expects large fleets with relatively high fleet average emissions would likely follow the tier phase-out schedule, due to the later compliance dates for the tier phase-out relative to the fleet average option, as shown in Tables 1 and 2. Under the phase-out schedule, large fleets may extend the life of their equipment while staying compliant. This may be attractive to fleets with a high proportion of Tier 3 engines that are certified to a PM emission standard higher than the proposed fleet average compliance standard in 2020. The tier phase-out schedule allows these Tier 3 engines to be operated in California until 2025, 2027 or 2029, depending on the fleet size and year of engine manufacture.

ARB analyzed each fleet and categorized them by compliance path. The analysis indicated about 67 percent of large fleets will follow the tier phase-out schedule and 33 percent of large fleets are anticipated to follow the fleet average schedule.

iii. Fleet Purchasing Habits

ARB assumes each fleet will keep the average age of their equipment steady across all years unless compliance with a standard forces them to accelerate turnover, bringing the average equipment age down for that year. If a fleet must remove and replace equipment to become compliant with an upcoming fleet standard, this analysis assumes a fleet will sell the oldest piece of equipment and replace it with a newer engine of equal horsepower and equipment type. It is important to note the tier of the engine is strongly correlated to the age of the engine. In most cases, removing the oldest engine in a fleet also means removing the highest emitting engine in that fleet.

iv. Fleet Decision-Making Process

Assumptions regarding fleet decision making were developed using eleven years of PERP registration data that contains detailed information on approximately 4,400 fleets in California. This data includes years when the current fleet standards became effective, providing insight on historic fleet response to meeting standards similar to the Portable Regulatory Amendments. Based on this data, ARB assumes that fleets will replace equipment in order to maintain a constant total horsepower throughout the Portable Regulatory Amendments. In addition, PERP data from 2005 through 2016 was used to estimate each fleet's average engine age and horsepower.

v. Direct Cost Estimation Results

The historical PERP data discussed above was used to inform an equipment turnover simulation model designed by ARB's emissions modeling team. The model predicts when engines are replaced by newer engines for a fleet to become compliant with a given compliance scenario. In this analysis two scenarios were run, the BAU and the Portable Regulatory Amendments.

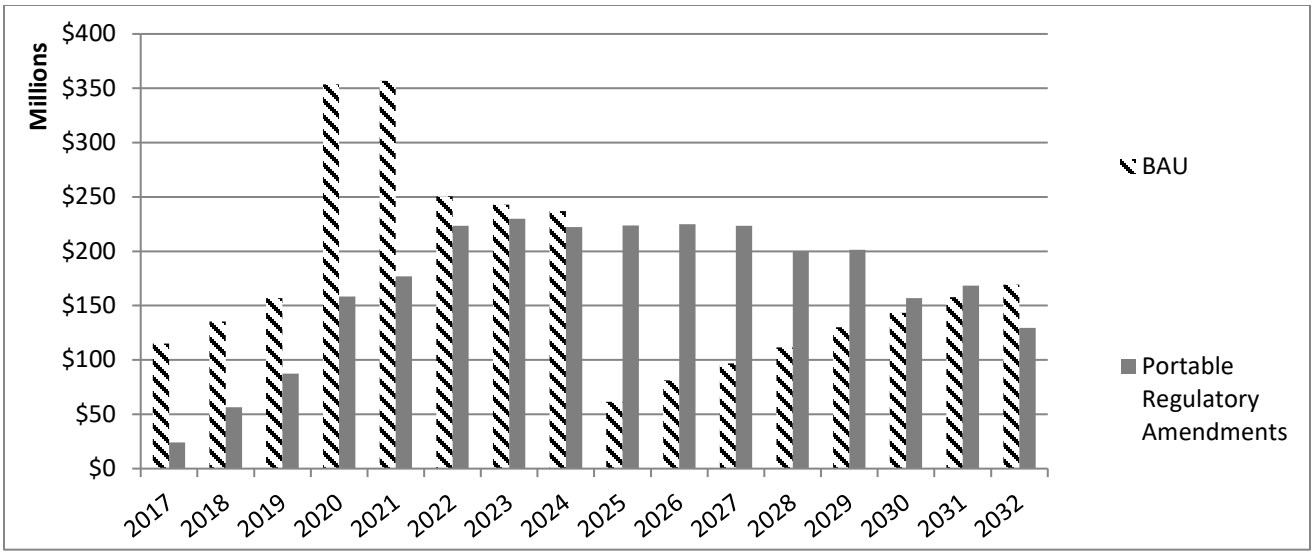
To illustrate the change in costs for equipment owners, the annualized equipment replacement cost is calculated under the BAU and under the Portable Regulatory Amendments from 2017 through 2020. The average annual amortized equipment replacement cost under the BAU is $190,236,334 from 2017 until 2020 (the final compliance date under the BAU). The average annual amortized cost under the Portable Regulatory Amendments is $81,676,965 between 2017 and 2020, assuming 67 percent of fleets use the phase-out option, and 33 percent use the fleet average. Looking at the incremental cost of the Portable Regulatory Amendments, there is an average annual equipment cost-savings (across about 4,400 fleets) of approximately $109 million dollars per year or 57 percent lower than the BAU, as shown in Equation 3 below.

$$\Delta\ Annual\ Equipment\ Cost = \$81{,}676{,}965\ -\ 190{,}236{,}334$$

$$= -\frac{108{,}559{,}369}{year} \qquad Eq.3$$

Figure 3 shows the estimated annual amortized equipment replacement cost under the BAU scenario, with a final compliance date of January 1, 2020, and under the Portable Regulatory Amendments with a final compliance date of January 1, 2029. Figure 3 illustrates the significantly higher annual equipment costs under the BAU relative to the Portable Regulatory Amendments in the near-term. Stakeholders report that high annual equipment costs, for example in 2020 and 2021, represent a significant burden to businesses, especially small businesses.

Figure 3: Annual Equipment Replacement Cost for BAU and Portable Regulatory Amendments



vi. Registration Costs

The Portable Regulatory Amendments include a registration fee increase that will impose a direct, on-going cost to businesses that register engines in PERP. The proposed fees will also result in additional revenue to all 35 air districts who receive a portion of the registration fees. The increased on-going cost to the regulated industry is estimated by multiplying the total registration fee increase by the estimated numbers of equipment for both initial and renewal registrations (which renew every three years). Table 5 outlines the current registration fees under the BAU and proposed registration fees under the Portable Regulatory Amendments. The fiscal impacts for state and local air districts are described in more detail in the Fiscal Impact section.

The equipment turnover model forecasts the number of engines that will be newly registered or renewed each year as a result of the Portable Regulatory Amendments. The cost to industry for initial registrations was calculated by multiplying the initial registration fee by the estimated number of initial registration applications processed in a given year. The cost to industry for renewals was calculated by multiplying the renewal cost by the number of registration renewals projected in a given year. The following equation, Equation 4, was used to calculate the number of renewals, in any given year:

$$R = \frac{TNE - IR}{3} \quad Eq.4$$

Table 5: Changes to On-Going Registration Costs

Initial Registration (3 year registration)			
Cost Type	BAU	Portable Regulatory Amendments	Change in Cost
Total for New Registration	**$620**	**$805**	**$185**
Registration Renewal (3 year registration)			
Cost Type	BAU	Portable Regulatory Amendments	Change in Cost
Total for Renewal	**$575**	**$740**	**$165**

Where R represents the total number of renewals in a given year, TNE represents the total number of engines in PERP, which the model holds constant, and IR represents the number of initial registrations in a given year as estimated by the equipment turnover model. To determine the number of renewals each year, the annual initial registrations (IR) are subtracted from TNE and divided by three to account for the three-year registration cycle. It is important to calculate the number of initial registrations and renewals since their fees differ from one another, which ultimately will affect the annual cost to industry. Aside from registration and renewal costs, there are additional registration action costs that are estimated to increase by 46 percent under the Portable Regulatory Amendments. Additional registration actions include document replacement requests, sticker replacement requests, and document correction requests. The frequency of registration actions will not be affected by the Portable Regulatory Amendments.

The equipment turnover simulation model estimates the PERP registration costs in each year given the equipment initially registered, or re-registered. Registration costs peak in 2020 for the both the BAU and Portable Regulatory Amendments at just under $11 million each. Under the Portable Regulatory Amendments, 2020 is predicted to be a peak year for registration fees due to the first set of compliance standards in both the phase-out and fleet average schedules. The projected annual numbers of initial registrations and renewals under the BAU and the Portable Regulatory Amendments are presented in Table 6. To find the total change in fees in each year, the difference in renewals between the Portable Regulatory Amendments and the BAU is estimated and multiplied by the corresponding change in registration fees. The districts will receive $60 of the registration increase for each new three-year renewal and newly registered engine. The remaining registration funds are distributed to ARB. The total increase in registration fees for the industry in 2017 through 2030 is estimated at $26,446,932, or approximately $1.9 million per year.

Table 6: Projected Number of Renewals and Initial Registrations by Year

	BAU		Portable Regulatory Amendments		Difference (Portable Regulatory Amendments – BAU)	
	# Newly Registered Engines	Renewals	# Newly Registered Engines	Renewals	# Newly Registered Engines	Renewals
2017	6,789	7,757	1,733	9,442	-5,056	1,685
2018	1,459	9,534	2,358	9,234	899	-300
2019	1,457	9,534	1,884	9,392	427	-142
2020	11,950	6,037	6,195	7,955	-5,755	1,918
2021	275	9,928	848	9,737	573	-191
2022	241	9,940	3,599	8,820	3,358	-1,120
2023	440	9,873	2,599	9,154	2,159	-719
2024	483	9,859	941	9,706	458	-153
2025	619	9,814	2,176	9,295	1,557	-519
2026	515	9,848	637	9,808	122	-40
2027	650	9,803	2,022	9,346	1,372	-457
2028	635	9,808	328	9,911	-307	103
2029	674	9,795	678	9,794	4	-1
2030	556	9,835	431	9,876	-125	41

vii. Diesel Exhaust Fluid Costs

The Portable Regulatory Amendments are anticipated to result in lower on-going costs due to the reduced need for Diesel Exhaust Fluid (DEF) as a result of the delay in equipment turnover requirements. Currently, all Tier 4 engine manufacturers have opted to use Selective Catalytic Reduction (SCR), which requires DEF to be sprayed on a catalyst to break apart NOx into inert nitrogen and water to reduce NOx emissions. DEF is a urea-water mixture that is consumed by the SCR at a rate proportional to the consumption rate of diesel fuel. In order to calculate how much DEF will be consumed in any given year under the BAU and Portable Regulatory Amendments, ARB calculated the amount of diesel fuel annually consumed by Tier 4 engines.

The equipment turnover model projects the number of Tier 4 engines operating in California for each year starting in 2016 under the BAU scenario and under the Portable Regulatory Amendments scenario.

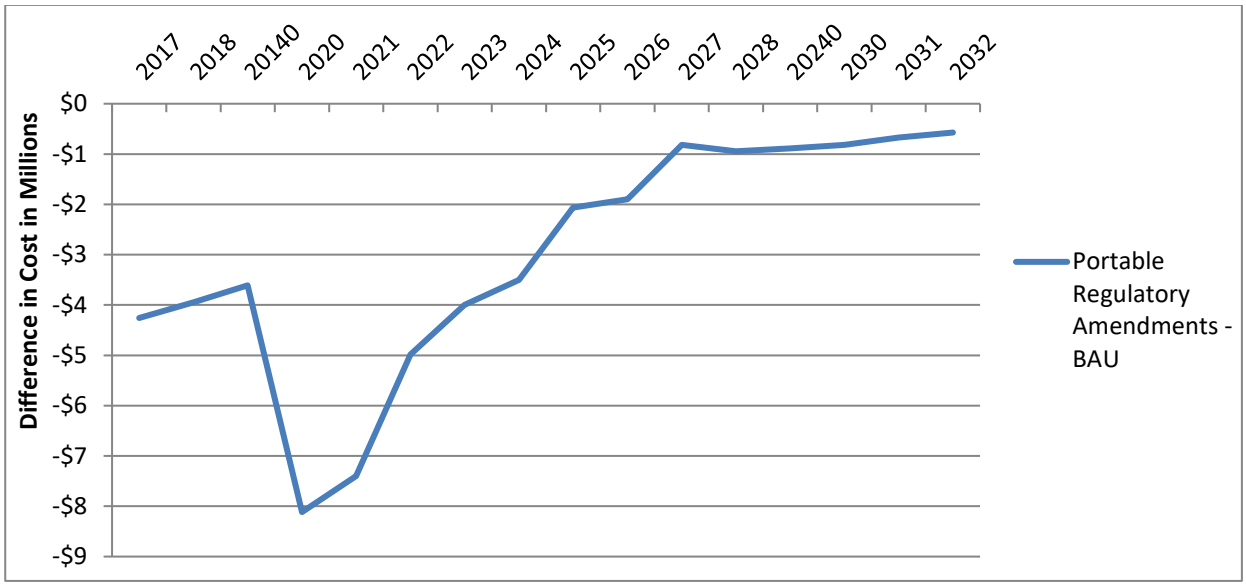
The amount of DEF required under the BAU and the Portable Regulatory Amendments is a based on the dosing rate, the DEF to diesel consumption ratio. The top three engine manufacturers' websites[8][9] show an average dosing rate between 1 and 5 percent. To estimate the highest cost impact, 5 percent is used as the dosing rate. The annual DEF consumption rate is calculated by multiplying the annual fuel consumption rate by the 5 percent dosing rate.

The cost of DEF in dollars per gallon is used to calculate the annual cost to all fleets as a result of the Portable Regulatory Amendments. Most equipment manufacturers purchase DEF in 55 gallon drums, for which the cost is estimated at $2.88 per gallon.[10] It is assumed that this cost remains constant (in 2015$) for the timeframe of this analysis.

Figure 3 shows slower engine turnover under the Portable Regulatory Amendments than under the BAU which results in fewer Tier 4 engines operating in California between 2017 and 2027. Because only Tier 4 engines use DEF, this will result in lower DEF costs until fleets purchase Tier 4 equipment. This change in annual DEF costs between the BAU scenario and the Portable Regulatory Amendments scenario is outlined in Figure 4. The figure shows that relative to the BAU, the Portable Regulatory Amendments result in cumulative cost savings of $19.9 million spread among all regulated businesses through 2020. Between 2017 and 2020, this cost savings represents about $0.4 million per year spread among all small fleets (8 percent of engine horsepower registered in PERP) and $4.6 million per year spread among all large fleets (92 percent of engine horsepower registered in PERP).

[8] https://www.cdc.gov/niosh/mining/UserFiles/workshops/dieselaerosols2012/NIOSHMVS2012Tier4TechnologyReview.pdf
[9] https://www.deere.com/common/docs/products/equipment/industrial_and_agricultural_engines/interim_tier_4_stage_3_b/brochure/it4_brochure.pdf
[10] https://www.google.com/search?q=def+55+gallon+drum&ie=utf-8&oe=utf-8#q=def+55+gallon+drum&tbm=shop

Figure 4: Difference in DEF Costs: Portable Regulatory Amendments - BAU



vi. Total Costs

The annual total cost or cost-saving to industry of the Portable Regulatory Amendments is the sum of the costs or cost savings of one-time equipment and engine replacements, as well as on-going costs and cost-savings from DEF consumption required for Tier 4 engines and equipment registration fees. The annual costs or savings can be summed over the life of the Portable Regulatory Amendments to calculate total costs. Summing the incremental cost of the Portable Regulatory Amendments (relative to the BAU) results in a cost-savings to industry of almost $630 million between 2017 and 2030.

E. Macroeconomic Impacts

1. Methods for Determining Economic Impacts

Regional Economic Models, Inc. (REMI), Policy Insight Plus Version 1.7.2 is used to estimate the macroeconomic economic impacts of the Portable Regulatory Amendments on the California economy. REMI is a structural macro-economic forecasting and policy analysis model that integrates input-output, computable general equilibrium, econometric and economic geography methodologies.

REMI provides year-by-year estimates of the total impacts of the Portable Engine Amendments, meeting the requirements of the Administrative Procedure Act and its

implementing regulations.[11] ARB uses the REMI single-region, 160-sector model with the model Reference case.
The Portable Regulatory Amendments are simulated in REMI by adjusting production costs for covered sectors to reflect the change in purchases of portable equipment, the increase in registration costs (adjusted for increased program costs), and the change in costs due to the maintenance of the portable equipment. The years of analysis are 2017 through 2030. These years are used to simulate the Portable Regulatory Amendments through 12 months post full implementation.

2. Inputs of the Assessment

Under the Portable Regulatory Amendments, fleets using portable equipment face a delayed requirement to purchase more expensive and lower emission equipment compared with the BAU. Fleets use existing engines longer which results in lower equipment capital and DEF costs through 2024 for many fleets.

The analysis begins with the equipment replacement costs, which are one-time capital costs that are amortized for five years, as outlined in the cost section and Table 7 and described below.

1. Production Cost Changes:
    a. Changes in costs for portable equipment are represented as a production cost increase or decrease to an industry depending upon the year.
    b. Changes in costs for DEF for Tier 4 engines are represented as a production cost increase or decrease to an industry depending upon the year.
    c. Changes in costs for registration and renewals are represented as production costs and are positive in all years except 2017 and 2020 when turnover is delayed (relative to the BAU) and fewer pieces of new equipment are registered.
2. Exogenous Final Demand Changes (changes in the demand faced by final product manufacturers as a result of changes in equipment and maintenance costs):
    a. The manufacturers of portable equipment face increased (or decreased depending upon the year) demand for their products as a result of purchase requirements under the Portable Regulatory Amendments.
    b. The manufacturers of DEF will face increased (or decreased depending upon the year) demand as a result of purchase requirements for the Portable Regulatory Amendments.
3. State and local spending:
    a. In all years except 2017 and 2020, there are estimated increases in State spending in response to the increased registration costs faced by portable engine owners and afforded to the State and localities. These fees are outlined in Table 5. A portion of the PERP fee is afforded to the State to process and register portable engines and a portion is afforded to the local air districts to implement and enforce the applicable requirements. Additionally, some State agencies and localities are also regulated parties that will change equipment purchases in

[11] Gov. Code, §§ 11346.3, 11346.36; 1 Cal. Code Regs., tit. 1 §§ 2000-2004;see also: http://dof.ca.gov/Forecasting/Economics/Major_Regulations/SB_617_Rulemaking_Documents/documents/Order_of_Adoption-1.pdf

response to the Portable Regulatory Amendments. The modeling of the costs to State and local entities is discussed in more detail in the next section.

Given the compliance requirements for engine purchases, businesses will spend less on equipment and DEF under the Portable Regulatory Amendments in early years relative to the BAU. Table 1 outlines the compliance dates based upon engine year and tier. As shown in Table 7, affected businesses will increase their engine purchases in later years under the Portable Regulatory Amendments to comply with the delayed engine requirements. The first two rows of Table 7 include the primary industries, or those that are directly affected by the Portable Regulatory Amendments. The two primary industries each represent 47 percent of the total equipment within the Portable Regulatory Amendments. The third and fourth row in Table 7 include the secondary industries, or those that are indirectly affected by the Portable Regulatory Amendments, discussed in greater detail below.

3. Assumptions and Limitations of the Model

The estimated economic impacts of the Portable Regulatory Amendments are sensitive to assumptions made by ARB. The following list outlines the key assumptions made in estimating the economic impacts for the purposes of modeling the Portable Regulatory Amendments in REMI.

1. The primary impacted industry is broken into the following categories using the North American Industry Classification System (NAICS):
    a. NAICS 5324 (Commercial and industrial machinery and equipment rental and leasing): This NAICS is used for the rental companies that offer portable equipment for rent to individuals and businesses. For this analysis, this portion of the industry is assumed to represent approximately 47 percent of the total equipment.
    b. NAICS 23 (Construction): The non-governmental and non-rental companies are grouped in the construction category. For this analysis, construction is assumed to represent approximately 47 percent of the total equipment.
    c. State Government: Less than 1 percent of currently registered fleets in the PERP database are State government entities.
    d. Local Government: Less than 5 percent of the currently registered fleets in the PERP database are local government entities.
    e. Federal Government: A portion of the currently registered fleets in the PERP database represent federal government entities, including military bases. Costs associated with these fleets are not entered into the analysis as the spending originates outside California. Portable equipment owned by the federal government represents less than 0.5 percent of the total equipment in the analysis.
2. The secondary industries, that manufacture PERP equipment or sell DEF, are broken down into:
    a. NAICS 3331 (Agriculture, construction, and mining machinery manufacturing): As fleet specific NAICS code information was not available, for simplicity it is assumed that all of the exogenous final demand is associated with the NAICS code representing agriculture, construction, and mining machinery manufacturing.

b. NAICS 4247 (Petroleum and petroleum products merchant wholesalers): This NAICS represents DEF sales relative to the BAU. The fleet turnover is estimated by keeping the average age of each fleet stable using data from the PERP database for the years 2003 to 2016, as discussed in Section (D)(2)(a)(iv). The fleet age will remain stable under natural turnover, but will be lower in years when there are compliance deadines, for example, 2017 and 2020 in the BAU.

2. All equipment is financed for five years using an 8 percent interest rate. While stakeholders identified varied financing depending upon the equipment type and business size, the 8 percent financing rate represents a conservative estimate.
3. Equipment purchases by State and local government are not modeled in REMI. The REMI model does not adjust tax collection in response to changes in spending. Thus, increased spending by government does not accurately reflect the benefits to the economy when modeled in REMI. State and local government represents less than 6 percent of portable equipment, thus their omission from the analysis is not anticipated to significantly impact the modeling results.

Table 7: REMI Inputs – Annual Cost or Savings for Portable Regulatory Amendments (Million Dollars)

			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Primary Industries	**Explanation**	**REMI Category**														
Commercial and industrial machinery & equipment rental and leasing (NAICS 5324)		**Production Cost (M$2015)**	-44.9	-37.9	-33.5	-115.4	-101.0	-44.8	-40.2	-35.1	50.5	44.9	37.4	31.1	22.2	16.9
Construction (NAICS 23)		**Production Cost (M$2015)**	-44.9	-37.9	-33.5	-115.4	-101.0	-44.8	-40.2	-35.1	50.5	44.9	37.4	31.1	22.2	16.9
Secondary Industries	**Explanation**	**REMI Category**														
Agriculture, construction, and mining machinery manufacturing (NAICS 3331)	**Equipment sales**	**Exogenous Final Demand (M$2015)**	-362.7	47.7	37.6	-501.3	61.4	246.0	104.5	31.2	204.9	-11.9	176.9	-49.3	-36.9	-24.1
Petroleum and petroleum products merchant wholesalers (NAICS 4247)	**DEF sales**	**Exogenous Final Demand (M$2015)**	-4.3	-4.0	-3.6	-9.6	-8.4	-7.2	-6.1	-5.0	-4.1	-3.0	-2.4	-2.0	-1.6	-1.1

The input values are rounded to the nearest $100,000.

4. Results of the Assessment

a) California Employment Impacts

As modeled, the Portable Regulatory Amendments would have a small impact on employment growth relative to the BAU scenario. Fleets are estimated to spend less on equipment in early years and use the increased profit as expenditures on labor and other capital - growing employment in California. Table 8 shows growth in early years when the Portable Regulatory Amendments delay equipment purchase requirements compared with the BAU. The REMI model responds to decreases in production costs by increasing output and thus increasing both capital and labor purchases. The delayed purchase requirements will thus increase employment for businesses that use portable equipment, while decreasing employment for the engine manufacturers that face a lowered demand predominantly in 2017 and 2020. Though some of the purchase requirements are delayed only until 2020 for some fleets (those using the fleet averaging option may not have to purchase equipment until later years), the growth in employment in early years offsets the slowing of growth in 2020 and 2021, yielding a slight decline not beginning until 2025. However this slowing of growth represents less than 0.01 percent of California employment in the most negatively impacted year.

Employment impacts are predominantly concentrated in the portable equipment industries, with large increased growth in the commercial and industrial machinery and equipment rental and leasing companies and construction in response to decreased costs to operate their businesses as outlined in Table 9. The growth of employment follows the delayed compliance dates, and decreases when the highest changes in expenditures result from the new compliance dates. Those industries see the largest positive impacts in 2021 at 0.16 percent and 0.07 percent respectively. For the construction sector, the largest decrease in growth is -0.03 percent in 2027. The decrease in growth for the rental industry is largest in 2030 at -0.03 percent; this is delayed likely because the construction sector responds more quickly to changes in costs as shown in most economic indicators. The portable engine manufacturers face the largest impacts in 2017 and 2020 when the demand for their products is decreased; the largest impact is almost a 7 percent decrease in growth in 2020 followed by five years of growth thereafter.

Table 8: Change in Employment Growth in California: All Industries

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
% Change	0.01%	0.01%	0.01%	0.02%	0.02%	0.01%	0.01%	0.01%	0.00%	0.00%	-0.01%	-0.01%	-0.01%	0.00%
Change in Total Jobs	1150	1850	1875	3850	4700	3425	2800	2225	-250	-1100	-1175	-1450	-1275	-1075

The value in each year is interpreted as the reference year value less the BAU value in that same year. The change in jobs is rounded to the nearest 25.

Table 9: Change in Employment Growth in California: Primary and Secondary Industries

		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Primary Industries															
	Change (%)	0.03%	0.05%	0.06%	0.13%	0.16%	0.15%	0.14%	0.13%	0.07%	0.02%	0.00%	-0.02%	-0.02%	-0.03%
	Change in Jobs	0	25	25	25	50	50	50	50	25	0	0	0	0	0
	Change (%)	0.02%	0.03%	0.03%	0.06%	0.07%	0.06%	0.04%	0.03%	-0.01%	-0.02%	-0.03%	-0.03%	-0.03%	-0.02%
	Change in Jobs	250	375	400	825	1000	750	575	425	-100	-350	-450	-475	-425	-350
Secondary Industries															
	Change (%)	-5.18%	0.69%	0.54%	-6.89%	0.87%	3.32%	1.39%	0.41%	2.55%	-0.15%	2.06%	-0.57%	-0.41%	-0.26%
	Change in Total Jobs	-250	25	25	-300	50	150	50	25	100	0	75	-25	-25	0

The value in each year is interpreted as the reference year value less the BAU value in that same year. The change in jobs is rounded to the nearest 25.

b) California Business

The Portable Regulatory Amendments are anticipated to have a small impact on the growth in final product output, referred here as output growth, relative to the BAU. As modeled, fleets would spend less on portable equipment in early years. Facing lower input costs, relative to the BAU, assuming no change in demand, these companies would, in theory, increase their output. Businesses that use portable equipment would be able to provide more services using the portable equipment given that the cost additional capital expenditures are not required in early years. Table 10 shows growth in output for primary industries in early years when the Portable Engine Amendments delay equipment purchase requirements. Though the purchase requirements are delayed to 2020 for most fleets (those using the fleet averaging option may not have to purchase equipment until later years), the growth in output in early years offsets the slowing of growth in the first compliance years, yielding a slight negative growth beginning in 2025 for construction and 2028 for rental companies. These results suggest that the construction sector is more

responsive to changes in production costs than the rental industry. Construction output growth follows a similar pattern to that of the employment values shown in Table 8 and employment changes are likely driven by the increased output growth in early years, and slight declines in growth in later years.

For manufacturers of portable engines, the largest declines in output growth are anticipated in 2017 and 2020, the years when under the previous regulation increased purchases of Tier 4 engines would have been required, leading to an increase in demand in quantity and quality of portable engines. This decline occurs in years when previously equipment would have been retired, but due to the delay can continue using the equipment given it still has useful life. However, these industries face sustained growth in most of the interim years as a result of the spread of equipment purchases to later compliance dates, which lead to increased demand for the manufacturers as compared to the BAU year-over-year. The impacts shown in Table 10 reflect the growth in output, categorized by industry, for businesses located in California. According to the REMI modeling results approximately 90 percent of the portable equipment manufacturing sector is located outside of California. Given the low concentration of manufacturing in California, the negative output effects are masked by the cost-savings to the portable equipment users that face lower input costs and as a result increase both their capital and labor purchases. Thus, GDP (output being one major component of GDP) should follow a similar pattern to changes in the output of the primary industries.

Table 10: Change in California Output Growth Relative to the Baseline

		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Primary Industries															
	Change (%)	0.0%	0.1%	0.1%	0.1%	0.2%	0.2%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%
	Change (M$2015)	$2.0	$3.0	$3.0	$7.0	$9.0	$8.0	$8.0	$7.0	$4.0	$2.0	$0.0	-$1.0	-$2.0	-$2.0
	Change (%)	0.0%	0.0%	0.0%	0.1%	0.1%	0.1%	0.1%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
	Change (M$2015)	$34.0	$51.0	$56.0	$116.0	$142.0	$112.0	$88.0	$67.0	-$9.0	-$49.0	-$66.0	-$72.0	-$67.0	-$58.0
Secondary Industries															
	Change (%)	-5.2%	0.7%	0.5%	-6.9%	0.8%	3.3%	1.4%	0.4%	2.6%	-0.1%	2.1%	-0.6%	-0.4%	-0.3%
	Change (M$2015)	-$40.0	$5.0	$4.0	-$53.0	$6.0	$26.0	$11.0	$3.0	$21.0	-$1.0	$19.0	-$5.0	-$4.0	-$3.0

The value in each year is interpreted as the reference year value less the BAU value in that same year. The values presented above are rounded to the nearest $100,000. Percentages are rounded to the nearest tenth.

c) Impacts on Investments in California

As modeled, the Portable Regulatory Amendments would produce very small impacts on private business investments in California, relative to the BAU scenario. There will be reductions in equipment purchases in early years, which will slow the growth in investments in the portable equipment manufacturing sector in early years. However in the REMI model estimates, approximately 90 percent of that portable equipment sector is located outside of California. The REMI modeling results suggest that PERP fleets have additional leverage to make other investments in early years. The availability of investment leverage for

these fleets slows in later years when the new compliance dates shift spending back to new capital equipment. Table 11 shows the change in California private investments from 2017 to 2030, ranging from a 0.20 percent increase in growth in 2021and a decline of 0.09 percent in 2027. The slowed growth in private investment is indiscernible from BAU given the size of California's $2.2 trillion economy.[12]

Table 11: Change in Gross Domestic Private Investment Growth in California

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Change (%)	0.06%	0.08%	0.08%	0.18%	0.20%	0.15%	0.12%	0.08%	-0.02%	-0.07%	-0.09%	-0.09%	-0.08%	-0.06%
Change (M$2015)	$52.0	$78.0	$85.0	$178.0	$218.0	$176.0	$142.0	$113.0	-$1.0	-$63.0	-$88.0	-$99.0	-$93.0	-$81.0

The value in each year is interpreted as the reference year value less the BAU value in that same year. The values presented above are rounded to the nearest $100,000.

d) Impacts on Individuals in California

The Portable Regulatory Amendments are estimated to produce a negligible change in personal income growth from 2017 through 2030, relative the BAU scenario. Table 12 shows that the greatest annual change in growth of personal income is 0.02 percent in 2021. The Portable Regulatory Amendments are anticipated to increase employment in most sectors in California, with only small decreases in growth beginning in 2025, as seen in Table 8. The increased employment results in increased growth of personal income. The growth in personal income follows in the same pattern as employment with a one year lag, and the growth in personal income makes a slight decline after 2026 as a result of increased compliance requirements and corresponding decrease in employment in the portable engine sector as seen in Tables 8 and 9.

[12] Source: California Department of Finance Gross State Product in CA – Annual from 1963: http://www.dof.ca.gov/Forecasting/Economics/Indicators/Gross_State_Product/

Table 12: Change in Personal Income Growth in California

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Change (%)	0.00%	0.01%	0.01%	0.01%	0.02%	0.01%	0.01%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Change (M$2015)	$64.0	$125.0	$138.0	$269.0	$361.0	$307.0	$271.0	$235.0	$62.0	-$26.0	-$51.0	-$92.0	-$93.0	-$87.0

The value in each year is interpreted as the reference year value less the BAU value in that same year. The values presented above are rounded to the nearest $100,000.

e) Impact on California Gross Domestic Product (GDP)

As presented in Table 13, the Portable Regulatory Amendments are estimated to slightly accelerate the growth of California GDP in the early years, relative to the BAU scenario. The growth in California GDP increases in most years analyzed, following closely with the California economic indicators described in the previous tables. The estimated increase in GDP growth from 2017 to 2025 is a result of increased employment, personal income, and output growth in the portable equipment sector, along with the indirect and induced benefits resulting from those primary sector impacts. These changes are a result of delayed compliance requirements that produce lower compliance costs in early years for industries that use portable equipment. As a result, these companies increase employment, other capital purchases, and output in their industry. Given that consumption (which will increase given increased California employment) and output are drivers for GDP, growth is anticipated to follow directly with those results as Table 13 indicates. Overall, the changes in growth of GDP are indiscernible from BAU given the size of California's $2.2 trillion economy.[13]

[13] Source: California Department of Finance Gross State Product in CA – Annual from 1963: http://www.dof.ca.gov/Forecasting/Economics/Indicators/Gross_State_Product/

Table 13: Change in California's Gross State Product Growth

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Change (%)	0.01%	0.01%	0.01%	0.02%	0.02%	0.02%	0.01%	0.01%	0.00%	0.00%	0.00%	-0.01%	0.00%	0.00%
Change (M$2015)	$134.0	$207.0	$216.0	$467.0	$572.0	$436.0	$375.0	$317.0	$1.0	-$109.0	-$129.0	-$172.0	-$155.0	-$135.0

The value in each year is interpreted as the reference year value less the BAU value in that same year. The values presented above are rounded to the nearest $100,000.

f) Incentives for Innovation

The Portable Regulatory Amendments are designed to encourage innovation in the manufacturing of cleaner portable engines. Currently, the engine manufacturers are working with portable equipment companies to design Tier 4 engines that will fit on the footprints of more types of equipment. However, more time is needed for research and development for some pieces of equipment, especially specialized equipment that is often the oldest equipment in the fleet. Delaying the compliance date will afford manufacturers the time needed to manufacture more Tier 4 engines and find additional opportunities for emissions reductions, economies of scale, and efficiencies to lower the cost of Tier 4 engines. Delayed compliance under the Portable Regulatory Amendments will ensure adequate time for innovation to occur.

g) Competitive Advantage or Disadvantage

Where permitting is required for California-based companies, out of state portable equipment used in California are also required to be permitted, resulting in a comparable increase in costs for both Californian and non-Californian companies. Thus, portable engine owners are not expected to face competitive disadvantages as a result of the Portable Regulatory Amendments, but instead this industry will face more favorable economic conditions. Those companies that have already complied will be able to use their engines for compliance and have already incurred the costs to comply. Thus, in compliance years, their spending will be lower than that of other business and may give them a slight advantage in compliance years. In future years, as new businesses are beginning to meet the requirements, those with Tier 4 engines already will face lower cost to offer the same service.

h) Creation, or Elimination, of Businesses

Due to the Portable Regulatory Amendments, there is anticipated to be growth in industries using portable equipment, as described in the previous sections, which may expand businesses in early years relative to the BAU scenario. However, any expansion of the portable equipment sector would likely be minor given that the purchase requirement of Tier 4 engines is not eliminated, but instead delayed. For instance, a business operating a large fleet of portable equipment including a Tier 2 wood-chipper would be required to meet a 2020 compliance date under the BAU. The Portable Regulatory Amendments would give the entity until 2023 (see Table 1) to retire the Tier 2 engine. This would provide them more time to become compliant, but is unlikely to drastically change their business model such that new businesses would be incentivized to enter the market. The manufacturers of portable equipment who face lower demand in early years as a result of delayed compliance may scale back their operations slightly, but may invest in the new Tier 4 technology which yields higher revenues. Though as indicated previously, the REMI model indicates that only about 10 percent of the agriculture, construction, and mining machinery manufacturing industry is located in California, thus the impact of the decreased demand faced by this industry is largely concentrated outside of California and is not likely to have a significant impact on businesses in California. Given the small impact on the industry, it is unlikely that there will be any creation or elimination of new businesses.

5. Summary and Agency Interpretation of the Results of the Economic Impact Assessment

The Portable Regulatory Amendments ensure the stability of the portable engine industry in California. Facing a shortfall in supply of the necessary engines to comply with the original compliance dates, the lengthened compliance timelines provide manufacturers the necessary time to make investments towards the creation of Tier 4 engines on multiple footprints, and provides fleet operators additional time to invest in newer, compliant equipment.

As modeled, the Portable Regulatory Amendments are unlikely to have significant impacts on the California economy. The estimated cost impacts of the Portable Regulatory Amendments represent a simulation of the potential effect on the directly affected industry that operates portable equipment, though actual fleet choices may vary.

F. Alternatives

In addition to the Portable Regulatory Amendments, ARB also evaluated several alternatives, as is required by the California Code of Regulations (CCR), Title 1, § 2003(e). To solicit alternatives from stakeholders, ARB presented a preliminary draft of the Portable Regulatory Amendments at the first series of public workshops on March 3, 8, and 10, 2016. Stakeholders submitted alternative proposals the following month, which ARB considered and incorporated into the current version of the Portable Regulatory Amendments. ARB continued to solicit alternatives at subsequent workshops held in June and September and at the workgroup meetings held in April, May, June, August, and October. Stakeholders responded

with input, most of which included minor variations of the current Portable Regulatory Amendments. As a result of the public process, the following are the finalized alternatives:

1. 18 Year Equipment Life with Relaxed Fleet Average Standards
2. Tiers 1-3 Phase-Out by 2025

Alternative 1 considers a scenario with delayed tier phase-out dates and relaxed fleet average option standards which will allow older engines to operate longer, especially large fleets that opt-in to the fleet average standards.

Alternative 2 considers a scenario in with accelerated tier phase-out and fleet average schedules compared to the Portable Regulatory Amendments and would result in higher emission reductions with additional costs to affected businesses.

A comparison of emissions impacts for the BAU, Portable Regulatory Amendments, and each alternative is presented in Figure 5 and Figure 6.

Figure 5: Statewide PM: All Scenarios

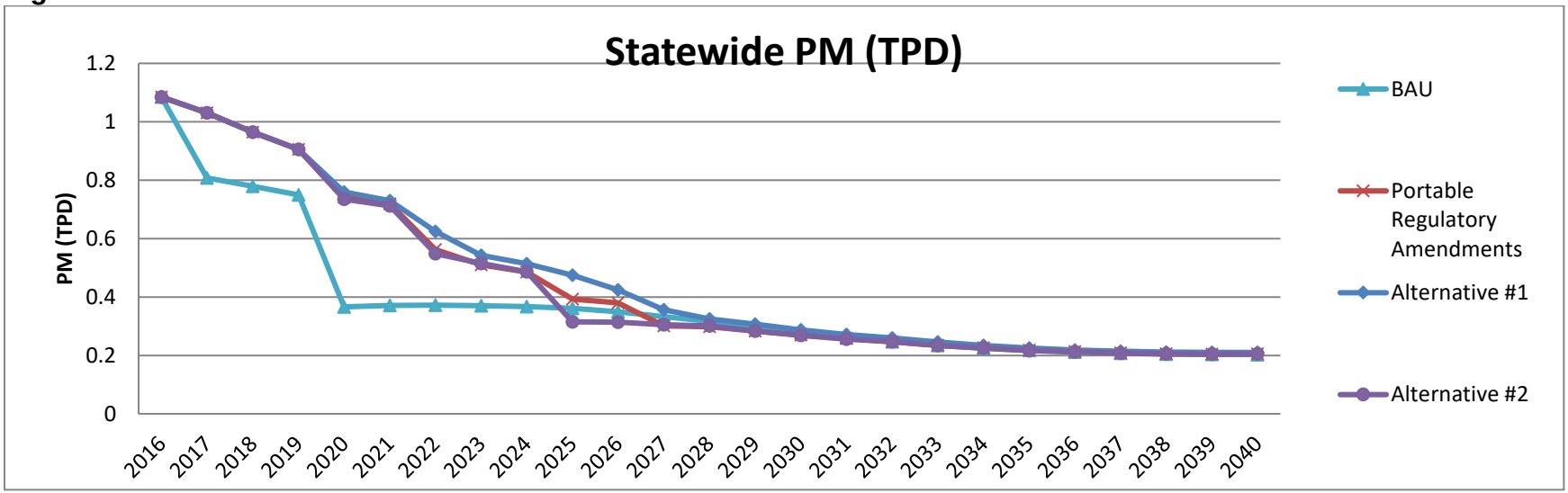
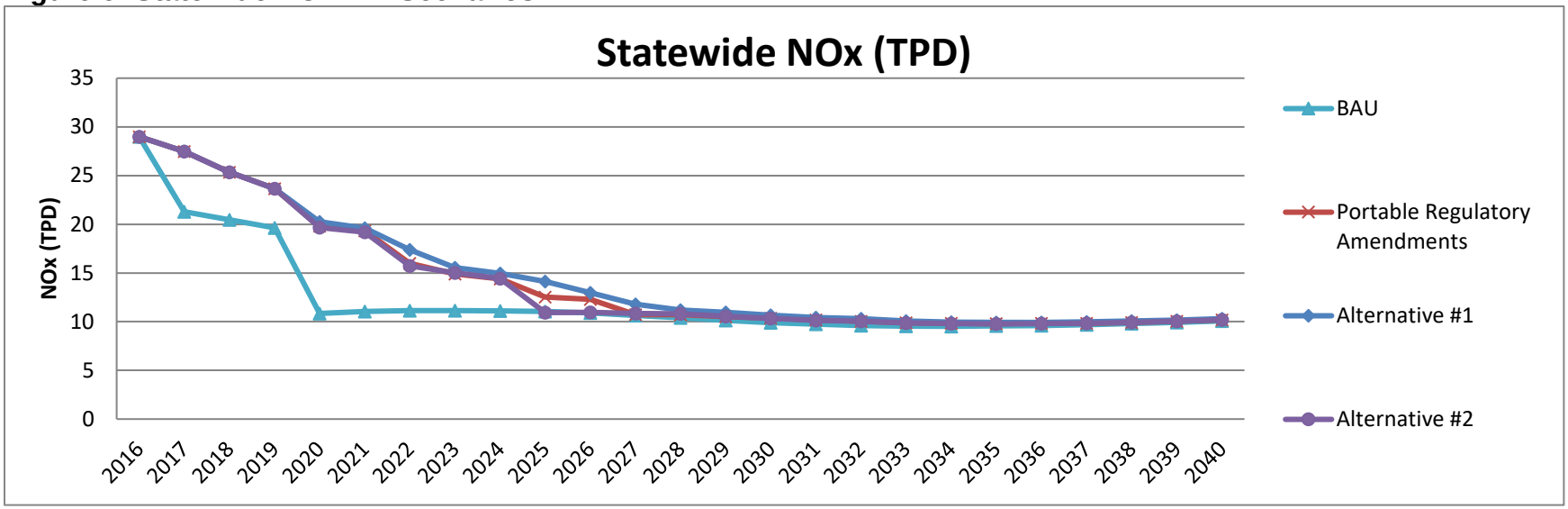


Figure 6: Statewide NOx: All Scenarios



1. Alternative 1: 18 Year Equipment Life with Relaxed Fleet Average Standards

a. Costs and Benefits

Alternative 1 is less stringent than the Proposed Regulatory Amendments because it allows older engines to operate longer. This alternative is not as costly for fleets but results in fewer emission reductions compared to the Portable Regulatory Amendments. Figures 5 and 6 show the PM and NOx respectively for this alternative.

Alternative 1 would provide additional direct cost savings to the businesses choosing to follow the fleet average option compared with the Portable Regulatory Amendments. The fleet emission standards would be higher than those following the fleet averaging schedule in the Portable Regulatory Amendments with a maximum difference in 2027 where a 0.06 g/bhp-hr fleet emission standard is required versus the proposed 0.03 g/bhp-hr fleet emission standard. Under Alternative 1, it is assumed that an increased number of fleets would choose the fleet average option. This change would require a fleet to have an average fleet composition of 65 percent Tier 4 and 35 percent Tier 2 or 3 engines, which would result in lower total cost over the life of the rule and, consequently, a lower annual cost of compliance to the affected businesses. Based on the assumptions in the equipment turnover model, the direct cost can be estimated using methods similar to that of the Portable Regulatory Amendments outlined in the Direct Cost section. However, the because the fleet option for Alternative 1 is more attractive (less restrictive) than for the Portable Regulatory Amendments ARB predicts that 50 percent of the large fleets will choose the fleet average option while the rest will choose the Tier phase-out option.

The costs and cost savings of the Portable Regulatory Amendments and Alternative 1 are compared from 2017 to 2027, which corresponds with the timeframe of the implementation of the Alternative. Using the same inputs used to estimate the change in average annual cost as the Portable Regulatory Amendments this alternative would require a change in the fleet purchasing habits as estimated using the equipment turnover model. The average annual equipment cost savings of Amendment 1 from 2017 to 2027 is $34.9 million, while the average annual equipment cost savings under the Portable Regulatory Amendments is estimated at $21.4 million over the same time frame.

b. Economic Impacts

Alternative 1 is less stringent than the Portable Regulatory Amendments, resulting in more growth in early years compared with both the BAU and the Portable Regulatory Amendments. Compared to the BAU, there would be small changes in GDP, personal income, private investment, or other economic indicators as shown in Table 14. The results for the alternative are not significantly different than the regulation in percentage terms.

c. Cost-Effectiveness

Cost-effectiveness is defined as the cost to achieve a ton of emissions reduction. In the case of Alternative 1, it is less costly for businesses on an annual basis while achieving fewer reductions through 2027, and those reductions are achieved later. Alternative 1 is a less cost-effective alternative compared to the Portable Regulatory Amendments.

d. Reason for Rejection

This alternative was rejected because the Portable Regulatory Amendments will result in higher emission reductions while remaining economically feasible. The lower cost to businesses offered by Alternative 1 comes with higher statewide emission rates between 2020 and 2027. Additionally, air districts with the most serious air quality issues nationwide have State and federal emission goals in 2025 and Alternative 1 would result in a 1.1 tpd of NOx and 0.06 tpd of PM statewide increase compared to the Portable Regulatory Amendments for that year.

Table 14: Change in Growth of Economic Indicators for Alternative 1 Compared to the Baseline

		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	Change (%)	0.01%	0.01%	0.01%	0.01%	0.02%	0.01%	0.01%	0.01%	0.00%	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%
	Change (M$2015)	133.9	207.6	215.7	401.1	513.2	335.8	252.1	193.2	-90.7	-190.7	-238.5	-242.4	-230.3	-190.6
	Change (%)	0.00%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.00%	0.00%	0.00%	-0.01%	-0.01%	0.00%
	Change (M$2015)	64.5	125.2	138.0	231.9	324.4	243.2	194.5	153.5	-8.3	-83.3	-127.4	-144.3	-148.7	-130.7
	Change (%)	0.01%	0.01%	0.01%	0.01%	0.02%	0.01%	0.01%	0.01%	0.00%	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%
	Change in Jobs	1150	1850	1850	3275	4200	2600	1825	1300	-950	-1650	-1925	-1875	-1725	-1375
	Change (%)	0.06%	0.08%	0.08%	0.16%	0.18%	0.12%	0.07%	0.05%	-0.04%	-0.10%	-0.11%	-0.10%	-0.09%	-0.08%
	Change (M$2015)	52.2	77.7	85.4	157.2	193.2	140.5	94.7	63.8	-35.9	-95.4	-123.6	-126.5	-116.2	-97.3

The value in each year is interpreted as the reference year value less the BAU value in that same year. The change in jobs is rounded to the nearest 25, while the dollar values are rounded to the nearest $100,000.

2. Alternative 2: Tiers 1-3 Phased-out by 2025

In Alternative 2 the final compliance date is two years earlier for large fleets and four years earlier for small fleets than in the Portable Regulatory Amendments resulting in a compressed timeframe for compliance and higher compliance costs in those years. The Portable Regulatory Amendments phase-out most Tier 1-3 engines by 2025 while Alternative 2 phases out all Tier 1-3 engines by 2025.

Alternative 2 would utilize the same fleet standards as the Portable Regulatory Amendments, but would require these fleet standards to be met earlier as shown in Table 15 below. This alternative would also use a different Tier Phase-out schedule, as shown in Table 16 below. This option achieves higher emission reductions by 2025, while the Portable Regulatory Amendments will achieve the same emissions reductions as Alternative 2 in 2029, though at a lower cost to industry.

Table 15: Alternative #2 Fleet Average Option for Large Fleets

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

Table 16: Alternative #2 Tier Phase-Out Schedule

	Engines rated 50 to 750 bhp		
	Large Fleet	***Small Fleet***	
Tier 1	1/1/2020	1/1/2020	1/1/2022
Tier 2	1/1/2022	1/1/2022	1/1/2025
Tier 3 built prior to 1/1/2009	1/1/2025	1/1/2025	NA
Flex engines (Tier 1,2, and 3)	Treated as the Tier the engine was built to.		

a. Costs and Benefits

Alternative 2 is a more costly alternative compared with the Portable Regulatory Amendments. It requires that all engines lower than Tier 4 phase-out in 2025 instead of 2029 as required under the Portable Regulatory Amendments. The costs and cost savings of the Portable Regulatory Amendments and Alternative 2 are compared from 2017 to 2027, which corresponds with the timeframe of the implementation of the Alternative. The Portable Regulatory Amendments provide four more years to purchase Tier 4 engines, thus spreading

the capital costs to ensure the businesses can comply. Alternative 2 results in slightly lower statewide emission rates, but also results in a higher cost to business. Figures 5 and 6 show the PM and NOx respectively for this alternative. The average annual equipment cost savings of Alternative 2 from 2017 to 2027 is $14.6 million while the average annual equipment cost savings under the Proposed Regulatory Amendments is estimated at $21.4 million over the same time frame.

b. Economic Impacts

Alternative 2 would result in a $6.8 million per year average annual cost savings to the primary industry when compared to the Portable Regulatory Amendments over the life of the amendment. The cost would be imposed on both large fleets and small fleets since the tier phase-out and fleet average schedules are accelerated relative to the Portable Regulatory Amendments. Table 17 compares the BAU with Alternative 2, and shows that estimated changes in California GDP, personal income, and employment are very similar to the economic impacts of the Portable Regulatory Amendments. Through 2021, most of the economic indicators are relatively the same; in 2025 the alternative results in lower growth that persists through 2030. This result is primarily due to the Tier 2 phase-out (for engines rated 50-750 bhp) and tier 1 phase-out (for engines rated >750 bhp) in 2022. While this alternative is more costly and the growth of GDP, employment, investment and personal income are all lower than the Portable Regulatory Amendments, these changes are very small compared to the size of the California economy.

c. Cost-Effectiveness

Alternative 2 would result in a higher compliance costs but would also result in slightly lower statewide emissions than the Portable Regulatory Amendments in early years. Fleets would be required to obtain more Tier 4 engines to stay in compliance with Alternative 2, which would lead to direct decreases in NOx and PM between 2017 and 2027.

d. Reason for Rejection

Alternative 2 achieves larger emissions reductions than the Portable Regulatory Amendments but these reductions are achieved with a higher cost to California businesses. Annual costs to businesses in some years would be higher than the costs to businesses under the BAU which stakeholders believe is economically unrealistic and could potentially result businesses leaving California.

Table 17: Change in Growth of Economic Indicators for Alternative 2 Compared to the Baseline

		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	Change (%)	0.01%	0.01%	0.01%	0.01%	0.02%	0.01%	0.01%	0.00%	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	0.00%
	Change (M$2015)	133.9	207.5	215.6	386.8	492.3	273.1	192.4	141.3	-228.1	-361.1	-315.3	-296.0	-260.3	-78.7
	Change (%)	0.00%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.00%	0.00%	-0.01%	-0.01%	-0.01%	-0.01%	0.00%
	Change (M$2015)	64.5	125.2	138.0	225.0	311.6	209.8	154.2	118.8	-82.6	-193.9	-190.5	-190.5	-176.8	-78.8
	Change (%)	0.01%	0.01%	0.01%	0.01%	0.02%	0.01%	0.01%	0.00%	-0.01%	-0.01%	-0.01%	-0.01%	-0.01%	0.00%
	Change in Jobs	1150	1850	1850	3175	4025	21225	1350	900	-1925	-2925	-2450	-2225	-1875	-525
	Change (%)	0.06%	0.08%	0.08%	0.16%	0.17%	0.10%	0.05%	0.02%	-0.10%	-0.14%	-0.14%	-0.12%	-0.09%	-0.04%
	Change (M$2015)	52.2	77.7	85.4	151.7	185.5	116.1	72.5	42.6	-91.1	-157.6	-156.9	-144.6	-124.6	-56.5

The value in each year is interpreted as the reference year value less the BAU value in that same year. The change in jobs is rounded to the nearest 25, while the dollar values are rounded to the nearest $100,000.

G. Fiscal Impacts

1. Local government

Local government agencies have two separate roles under the Portable Regulatory Amendments. Many local government agencies register their portable equipment units in PERP and will see lower equipment and DEF costs and higher registration fees under the Portable Regulatory Amendments compared to the BAU scenario. In the second role, the 35 California air districts regulate portable equipment and enforce the PERP registrations. A portion of the higher registration fees in the Portable Regulatory Amendments will be distributed to the local air districts representing increased revenue to local government.

The net cost or savings to PERP registrants, including local government, will vary annually depending on the age of the portable engines, fleet composition, and other factors. Local governments comprise about 4.8 percent of total portable equipment (by horsepower) and the Portable Regulatory Amendments are estimated to result in an annual cost-savings of $492 million to all regulated entities between 2017 and 2020 (see Table 7 for additional detail). This cost savings includes lower expenditures on equipment and DEF and increased registration fees. The estimated annual cost savings to local government agencies is approximately $23.6 million each year between 2017 and 2020.

Increased registration fees (for all fleets including those owned by local agencies) will provide increased revenue to local air districts. Currently, the district portion of the fee is $345 for both a renewal and an initial registration. Under the Portable Regulatory Amendments the fee would increase to $405 ($60 increase per engine). In total, the air districts are expected to see an increase in revenue of approximately $672,000 per year on average between 2017 and 2030. The amount allotted to each district will vary depending upon the number of renewals or new registrations annually in each district. As indicated in the Cost Section (D)(2)(a)(vi.), to find the total increase in fees in each year, the difference between the renewals or newly registered engines in any given year for the Portable Regulatory Amendments and the BAU is obtained (see Table 6), then these values are multiplied by their corresponding increase in fees. The districts will receive $60 of the increase for each new renewal and newly registered engine and the remaining funds are distributed to ARB. This increase in revenue is expected to cover any additional staffing or training needs at local air districts.

2. State Government

State government comprises about 1 percent of the total registered horsepower in PERP and is anticipated to have an average net annual cost savings of approximately $4.9 million (1 percent of the total cost of $492 million which is outlined in Table 7) between 2017 and 2020.This cost savings includes lower expenditures on equipment and DEF and increased registration fees. Thus, the Portable Regulatory Amendments are expected to represent a net savings to State government agencies who register PERP equipment of approximately $4.9 million each year from 2017 to 2020.

3. ARB

As outlined in the cost section, the increase in registration costs will increase the revenue to support the PERP by $185 for each new registration and $165 for a renewal of each registration (see Table 5). ARB is expected to retain approximately $1.2 million per year on average between 2017 and 2030, after accounting for fees to local government. This is calculated by multiplying the annual new registration numbers (presented in Table 6) by $185, and the registration renewals (also presented in Table 6) by $165, summing these numbers and subtracting the portion of registration fees apportioned to local government.

PERP was established as a self-funded program. However, in recent years, it became apparent that the program is both understaffed and underfunded. The proposed fee increases would pay for additional full-time staff to manage and support the program, and for additional information technology (IT) resources to support program implementation. The implementation of the Portable Regulatory Amendments will require changes to the DMS for amendment implementation. These staffing changes will ensure the program will be able to handle the additional registrations that will be processed for large fleets choosing the fleet average option since they will now need to register all their portable engines in PERP. Once the proposed fee increases are in place, ARB will submit a budget change proposal to address any staffing shortages, IT resource needs, and other implementation resources as deemed necessary.

Appendix C-2

REVISED Standardized Regulatory Impact Assessment

Table of Contents

A. SUMMARY

The Portable Engine Airborne Toxic Control Measure (ATCM) is a regulation initially adopted in 2004 that set emissions requirements for portable engines to reduce exposure to toxic diesel particulate matter (PM) and protect public health. The ATCM works in concert with the Portable Equipment Registration Program (PERP) to allow fleets to register portable equipment 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. This has substantially increased the cost to regulated parties compared to the estimates at the time of ATCM adoption and, critically, means that the program as now structured will not produce public health benefits on the scale and timing intended because program participants will not be able to fully comply. The proposed amendments recapture these benefits by setting out a reasonable compliance timeline based on today's information on fleet economics and technology availability to provide a glide path that will ensure compliance.

Compliance with the 2004 ATCM, which sets these standards, is not possible for the majority of fleet owners due to high annual equipment replacement costs. Based on historic enforcement data, behavior of owners in response to regulatory requirements, and comment from owners and other interested persons, fleets that cannot comply with the ATCM will operate out of compliance resulting in increased statewide emissions. The purpose of the proposed amendments to the PERP and ATCM (together referred to as Portable Regulatory Amendments) is to safeguard public health benefits by ensuring the emissions reductions envisioned in the original ATCM will be met while avoiding costly noncompliance problems that would otherwise result from the technologically and financially challenging 2017 and 2020 fleet average emission standards set by the current ATCM. The Portable Regulatory Amendments are achievable and enforceable which will lead to high compliance and a net decrease in emissions compared to existing conditions under the current ATCM.

1. Regulatory History

a. ATCM

ARB adopted the ATCM in 2004 as part of a broad initiative, called the Diesel Risk Reduction Plan, to control diesel particulate emissions from many diesel engines and equipment to protect public health. The ATCM prohibits use of older portable engines that emit high levels of air pollution, sets strict engine eligibility for portable engines registering in PERP, limits districts to permitting only engines certified to meet federal emission standards, and requires all fleets to meet fleet emission standards.

The fleet average standards required by the ATCM and corresponding compliance dates can be found in Table 1.

Table 1: Existing ATCM Fleet Average Standards

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

When ARB adopted the ATCM in 2004, the rulemaking relied on several assumptions about developing new technologies as the basis for establishing the fleet emission standards. The first critical assumption was that new engines certified to the federal emissions standards[14] would be available at the time manufacturers were required to produce them. The federal emission requirements established a regulatory structure where non-road engines would be produced with progressively cleaner emissions over time and the result is a "tiered" engine structure with Tier 1 being the least clean and Tier 4 Final being the cleanest. As an example of the certified engine tiered structure, Table 2 below lists the years in which engine manufacturers were required to begin producing each tier along with each tier's emission standards for the 175-299 horsepower range.

Table 2: Tier Production Dates and Associated Emission Standards for Engines 175-299 horsepower

Tier	*Effective Date*	*PM (g/bhp-hr)*	*NOx (g/bhp-hr)*
1	1996	0.40	6.9
2	2003	0.15	4.9*
3	2006	0.15	3.0*
Interim 4	2011	0.015	1.5
4 Final	2014	0.01	0.3

*Standards given are NMHC + NOx

The costs presumed an abundance of Tier 4 engines would be available for fleet owners to purchase at competitive prices and that these purchases could be made well before the emissions standards were required. The rulemaking also assumed that where Tier 4 engines were not yet available, engines could be retrofitted to comply with the standards. In reality, the costs materialized as much higher than anticipated, Tier 4 engines were not available as early as anticipated, and retrofits are not available for many engine categories. In response to the lack of available technology, the California Air Resources Board (ARB) released Enforcement Advisory 347[15] in December 2015 which states ARB will not enforce the 2017 fleet standards, because of these pending amendments to the ATCM.

[14] 40 CFR 89, 1039 https://www.gpo.gov/fdsys/pkg/FR-2004-06-29/pdf/04-11293.pdf
[15] Advisory 347 https://www.arb.ca.gov/enf/advs/advs347.pdf

b. PERP

Portable engines (and associated equipment) and non-combustion equipment units are regulated by the ARB and by the 35 local air districts in California. Examples of portable engines include those used in well drilling, service or work-over rigs, power generation (excluding cogeneration), pumps, compressors, diesel pile-driving hammers, welding, cranes, wood chippers, dredges, and military tactical support equipment applications. Non-combustion equipment units are pieces of portable equipment that emit non-combustion related particulate matter and are used in activities that include, but are not limited to, confined and unconfined abrasive blasting, concrete batch plants, sand and gravel screening, rock crushing, and unheated pavement recycling and crushing. Permitting requirements for portable engines and equipment units vary among the air districts.

In 1995, the California legislature mandated that ARB establish a fee-based, voluntary, uniform, and statewide registration program for portable equipment, the PERP. This statewide program provides a streamlined registration path for portable equipment owners that operate in multiple air districts. Absent a uniform statewide program, equipment owners would have to obtain permits from each air district in which the engine or equipment unit operates, potentially leading to multiple permits for one piece of equipment. Because of the California legislature's mandate, ARB adopted the PERP regulation in 1997, which defined the equipment allowed to register in PERP, set operational limits for registered equipment, established registration procedures, and set registration fees. ARB distributes a portion of the registration fees to the local air districts that perform inspections and enforce the operational conditions of PERP registrants.

2. Goal of the Portable Regulatory Amendments

The purpose of the proposed amendments is to safeguard public health benefits by ensuring the emission rates ultimately envisioned in the original ATCM will be met while avoiding costly noncompliance problems that would otherwise result from the technologically and financially challenging 2017 and 2020 fleet average emission standards set by the current ATCM. To accomplish this goal, the Portable Regulatory Amendments:

- Maintain a uniform statewide registration program for portable equipment
- Simplify fleet emission requirements
- Improve and simplify enforcement
- Develop feasible compliance schedules

3. Need for the Portable Regulatory Amendments

There are multiple factors impacting the decision to develop the Portable Regulatory Amendments: (1) High fraction of older engines in the existing inventory; (2) Lack of available

retrofit technologies; (3) Repowers not feasible in most applications; (4) Federal emissions standards allowed manufacture of higher-emitting engines for longer than anticipated; (5) High cost of compliant engines and equipment; and (6) Tier 4 engines rated at greater than 750 bhp cannot meet current emissions requirements. These factors together make the current standards in 2017 and 2020 financially and, in some cases, technologically infeasible. In addition to these factors, the Portable Regulatory Amendments address stakeholder concerns and improve enforceability. At the time of the 2004 ATCM adoption, ARB assumed that equipment owners would replace equipment with new, compliant equipment; retrofit existing engines with after-treatment devices; or repower existing equipment by replacing retired engines with new, compliant engines. In reality, deployment of the necessary technology to meet the 2004 standards was delayed. As a result, meeting the 2020 emissions standards will be prohibitively costly for the majority of fleets, resulting in high levels of non-compliance, and higher emissions than anticipated in the 2004 ATCM.

The technology to be used to retrofit engines, known as Verified Diesel Emission Control Strategies (VDECS) did not materialize as anticipated. VDECS are after-treatment devices certified by ARB to reduce PM emissions by 25 to 85 percent, depending on the type. These after-treatment devices are used for various diesel engine applications ranging from heavy duty on-road engines to harborcraft. There are seven VDECS available for non-road diesel engines and they all use PM filter technology certified to reduce PM emissions by 85 percent.[16] Installing a VDECS on an engine does not change the engine's federal tier certification level, further discussed below. Since the VDECS PM filters are not built into the original design of the engine, manufacturers faced challenges manufacturing and certifying VDECS for the portable sector due to the large number of different applications (e.g., chippers, generators, pumps, compressors, crushers, etc.). The number of different engine manufacturers and models, the varying duty cycles for each application, and the economic uncertainty of entering a relatively small and diverse market. PERP engine registration data indicates that to date, only 7 of 30,000 registered engines have been retrofitted with emission control devices.

ARB assumed that many fleets could repower existing equipment, by replacing engines in existing chassis with new engines that meet federal emission standards for non-road diesel engines, established in advancing tiers that progressively become more stringent (i.e. the higher the tier, the lower the emissions). Currently, the most stringent is Tier 4. The 2004 ATCM would require approximately 90 percent of engines in a fleet to meet federal Tier 4 emission standards for newly manufactured engines by 2020.

Tier 4 engines with a PM emission standard ten times lower than that of a Tier 3 were expected to be built and available to end users in 2011. However, this did not materialize as anticipated, and, once developed, were much larger than anticipated. Because of this larger footprint, Tier 4 engines would not fit in the chassis of old equipment, making repower impossible. Equipment manufacturers were forced to redesign the equipment chassis to accommodate the larger Tier 4 footprint. This redesign caused further delay in the availability of complaint equipment and led to a doubling of the cost of new equipment with Tier 4 compliant engines compared to previous estimates.

[16] Off-Road Diesel Vehicle Regulation and Verified Diesel Emissions Control Strategies (VDECS) https://www.arb.ca.gov/msprog/ordiesel/vdecs.htm

A federal program designed to provide flexibility to equipment manufacturers,[17] also contributed to challenges in meeting the ATCM. This program, called the Transitional Program for Equipment Manufactures (TPEM) program, allowed equipment manufacturers to sell up to 80 percent of their equipment with engines certified to the previous tier after a new tier requirement becomes effective. These engines are referred to as flex engines. Since their inception federally, flex engines have been eligible for PERP registrations regardless of emission certification rates. Because of low annual sales volumes and high costs to accommodate the larger footprint of Tier 4 engines in portable equipment packages, a large volume of Tier 2 and 3 flex engines were sold and registered in the portable market[18] since 2012. Between 2012 and 2015 the majority of newly registered engines in PERP were flex engines. These engines do not meet the ATCM 2017 or 2020 fleet average standards for most engine horsepower categories. Many fleets purchased these engines, because they were often the only engines available on the market. However, to meet upcoming ATCM fleet average standards fleets would have to rapidly turn over this equipment after only three to five years of use, when the expected service life is at least 20 years. The Portable Regulatory Amendments seek to improve statewide emissions by limiting flex engine eligibility in PERP to those produced to the two previous emission standards.

In addition to high compliance costs, the complexity of state and local portable engine registration requirements create challenges for enforcement. Fleets can register in PERP, register locally, or may have engines operating in districts that do not require permits. ARB can only determine if a fleet is in potential non-compliance based on the engines registered in PERP, but cannot confirm if all engines in a fleet are registered. The local air district, where the fleet operates most of its engines, must then further investigate to identify all engines that belong to a fleet in order to determine if the fleet is in fact in non-compliant. With the current enforcement structure, ARB anticipates having the ability to enforce upon 250 fleets per year. This implies that the probability that a fleet is caught operating out of compliance is low.

A fleet may reasonably be expected to comply with a regulation if the cost of compliance is less than the reasonably expected cost of being found non-compliant. With the current high cost of compliance and non-complaint fleets facing a low probability of detection, ARB estimates about 80 percent of fleets will remain out of compliance with the 2020 fleet average standards. This estimate is consistent with stakeholders' comments to ARB stating that they cannot afford to comply with the 2004 ATCM requirements. It is also consistent with historic enforcement data that indicates non-compliant fleets will operate out of compliance until enforced upon by the local air districts. High levels of non-compliance will result in higher emissions rates that will not meet the 2004 ATCM emissions reduction goals.
Finally, Tier 4 technology in the greater than 750 bhp engines applications is particularly challenging. Due to TPEM allowances in the emission standard, it can take a year or more for Tier 4 equipment to be delivered once an order is placed. In some applications, equipment with Tier 4 engines in the greater than 750 horsepower category is still not available today.

[17] 40 CFR 1039.625 https://www.gpo.gov/fdsys/pkg/CFR-2014-title40-vol33/pdf/CFR-2014-title40-vol33-sec1039-625.pdf

[18] Note: PERP and the related airborne toxic control measure are not engine-specific emission limitations. Engines that meet the federal emission standard, including the flex accommodation in the TPEM program, are legal to register in PERP.

Moreover, final Tier 4 technologies are certified to a 0.03 g PM/bhp-hr standard that was set after the portable rules were originally adopted. This level exceeds the current Portable Engine ATCM requirement of 0.02 g PM/bhp-hr. As such, the existing regulatory requirement cannot be met with final Tier 4 equipment in engines rated to greater than 750 bhp.

The Portable Regulatory Amendments were developed in response to stakeholder comments to provide reasonable compliance standards and improve the enforceability of the ATCM. This SRIA includes an analysis of the cost and emissions impacts associated with enforcement of the current ATCM by predicting fleet behavior. The cost of the Portable Regulatory Amendments compared to this baseline are included in Section C, and macroeconomic modeling of the Portable Regulatory Amendments is in Section D.

4. Identification of the Baseline (Referred to as Business As Usual)

a. Business as Usual Overview

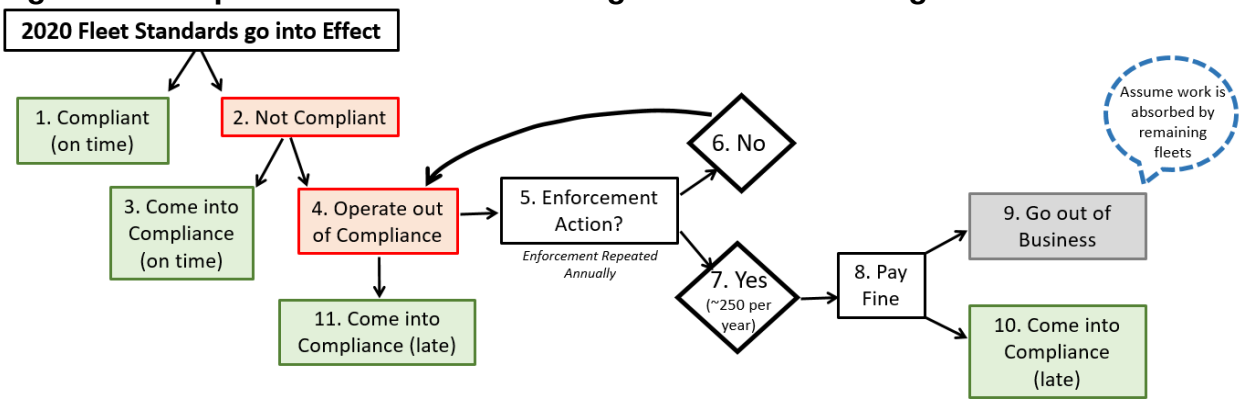
The business as usual scenario (BAU), used as a baseline for this economic analysis, assumes the ATCM 2020 fleet average standards are implemented and enforced. This BAU attempts to forecast a real world scenario using current portable fleet emission values, costs of compliance, and historic fleet operating behavior. The existing ATCM fleet average standards first became effective in 2013 and become increasingly more stringent in 2017 and 2020 (Table 1). As mentioned previously, in response to lack of available technology, ARB released Enforcement Advisory 347 and the 2017 emission standards were not enforced. Compliance rate projections performed by ARB suggest that currently, approximately 50 percent of fleets are non-compliant across the three 2017 fleet average standards. Accordingly, the BAU starts with current fleet conditions, including the extent of non-compliance with the 2017 standards, and projects fleet response to enforcement of the 2020 fleet average standards.

Although some fleets with newer engines may be able to meet the 2020 emission standards, many fleets own older engines and most would face high costs to comply. While it is possible that the 2020 fleet average standards could force fleets out of business, it is likely that most fleets would operate out of compliance due to high costs and low enforcement rates. ARB used historic PERP fleet registration and cost data to project which fleets would come into compliance, which fleets would not comply, and which fleets would go out of business due to high costs related to the current 2020 emission standards. The modeling data includes current fleet composition, current fleet emissions, estimates of the cost to comply with the 2020 fleet average standards, and estimates of enforcement penalties if a fleet does not comply. Given the limited enforcement capability of ARB and local air districts, equipment replacement costs required to comply with the 2020 standards are much higher than the expected value of enforcement fines associated with non-compliance. This results in projected widespread non-compliance. Fleets are projected to operate out of compliance until they comply through natural equipment turnover and are assumed to only comply earlier or go out of business if enforced upon by a local air district or ARB.

Enforcement data collected from the implementation of the ATCM 2013 fleet average standards with about 1,200 potentially non-compliant fleets indicates the local air districts'

finite number of enforcement staff limits the maximum number of non-compliant fleets they can enforce upon statewide to approximately 250 on an annual basis. Therefore, the BAU assumes a small fraction of fleets operating out of compliance will be cited annually leaving the remaining fleets to continue operating out of compliance risking enforcement in subsequent years. Fleets that are cited incur penalties and must make the decision to pay fines and purchase the required equipment to comply or go out of business. ARB assumes the demand for PERP services will remain constant. To determine the emission impact, the workload of fleets that go out of business is predicted to be distributed proportionally among the remaining non-compliant and compliant fleets. Finally, fleets that operate out of compliance but are not enforced against will lower their fleet emissions over time through natural turnover until they become compliant or are enforced against in future years. Figure 1 shows the modeled potential compliance paths fleets may follow in response to the 2020 fleet average standards.

Figure 1: Compliance Paths with Existing ATCM Fleet Average Standards



b. Methodology for Developing the BAU

ARB developed an equipment turnover simulation model to forecast individual fleet equipment replacement schedules based on each fleet's average engine age and anticipated compliance with fleet average standards. This model simulates equipment turnover for each fleet for the following three scenarios:

1. Natural Turnover – No effective rule
2. 100% Compliance with the Existing Fleet Standards
3. Portable Regulatory Amendments

The Natural Turnover and 100% Compliance with the Existing Fleet Standards scenarios were both used in constructing the BAU.

i. Box 1 - Compliant (on time)

Every fleet's compliance costs were calculated by taking the fleet value in 2020 under the 100% Compliance with the Existing Fleet Standards scenario and subtracting the fleet value in 2020 under the Natural Turnover scenario. Fleets with a compliance cost equal to zero are

assumed to comply with the 2020 fleet standards solely through natural turnover. These 883 fleets are assumed to fall into Box 1 of the diagram above, Compliant (on time).

ii. Box 2 – Not Compliant

The remaining 3,590 fleets that do not comply solely through natural turnover were further analyzed to determine if they would come into compliance by comparing each fleet's cost of compliance to the expected cost of non-compliance. A fleet that is found to be non-compliant is required to both come into compliance and pay a fine. Thus, the expected cost of non-compliance is defined as the probability of being caught operating out of compliance multiplied by the amount of the fine plus the cost of coming into compliance. ARB makes an economic assumption that a fleet would not come into compliance if the compliance cost is higher than the expected cost of non-compliance, as shown in the equation below.

Fleets will not comply if: $CC > P(E) * [Min(F, FV) + CC]$

Where CC is the compliance costs, $P(E)$ is the probability of enforcement, F is the enforcement fines, and FV is fleet value. Each of these variables are described in detail below.

The probability of enforcement, $P(E)$, is a value derived from average annual enforcement rates observed during the implementation of the 2013 fleet average standards. As part of the 2013 fleet compliance implementation, ARB created a list of non-compliant fleets biannually which was distributed to all thirty-five local air districts in California who enforce the existing ATCM's fleet requirements. During a subsequent two-year period, the original list of 1,300 non-compliant fleets was reduced by about 500, indicating approximately 250 fleets per year were successfully enforced upon. Based on this experience and data, ARB has assumed enforcement resources will be limited to a statewide rate of 250 fleets per year. The probability of a non-compliant fleet being enforced upon was calculated by taking the enforcement rate of 250 and dividing it by the total number of potentially non-compliant fleets, which is 3,590, yielding a probability of enforcement, $P(E)$, equal to 6.9 percent.

ARB consulted with representatives from several local air districts regarding their penalty assessment procedures to determine potential enforcement fines, F. Districts assess penalties for non-compliance based first on the statutory penalties in Health & Safety Code (HSC) Section 42402. These penalties are $1,000 or $10,000 per day in strict liability and $25,000 per day for an intentional or negligent violation. (See HSC, §§ 42402, 42402.1.) Only in rare instances would the penalty exceed these maxima due to exacerbating circumstances. Pursuant to HSC Section 42403, local air districts are required to consider a set of both aggravating and mitigating factors when determining penalty amounts. The aggravating factors that must be considered are listed below:

1. The extent of harm caused by the violation.
2. The nature and persistence of the violation.
3. The length of time over which the violation occurs.
4. The frequency of past violations.

Districts next consider mitigating factors listed in HSC Section 42403 in order to assess an appropriate penalty with the ultimate result of bringing the fleet into compliance. In some instances, compliance requires the fleet to cease operation.

The mitigating factors local districts are required to consider are listed below:

1. The record of maintenance.
2. The unproven or innovative nature of control equipment.
3. Any action taken by the person including the nature, extent, and time of response of any cleanup and construction undertaken to mitigate the violation.
4. The financial burden on the defendant.

Given the complexity of fine-setting it is difficult to predict actual fine values a fleet may incur for non-compliance. ARB conservatively assumed a district would set fines not to exceed either 1) $365,000 ($1,000 per day) for each year a fleet is out of compliance, as allowed by the HSC or 2) the value of the fleet, whichever is lower; i.e., *Min(F,FV)*. Though the HSC sets a maximum fine value per year, districts often consider mitigating factors and do not charge maximum fines. If the fleet value is less than $365,000, for purposes of predicting reasonably foreseeable responses, it is likely that the fleet could not afford the maximum fine, and the district would consider this as a mitigating factor.

Fleet value, *FV*, was determined by summing the value of all the engines in a fleet. Engine value is further discussed in Section C. Using these criteria and assumptions, 3,556 fleets are projected to operate out of compliance.

iii. Box 3 – Come into Compliance (on time)

Some fleets would opt to incur the additional costs above natural turnover to come into compliance if the 2020 fleet average standards were enforced. If the cost of compliance is less than the probability of being caught operating out of compliance multiplied by the amount of potential fines plus the cost of compliance, a fleet is assumed to come into compliance. Using the criteria and assumptions outlined above, 34 additional fleets will come into compliance.

Fleets will comply if: $CC < P(E) * [Min(F, FV) + CC]$

iv. Box 4 – Operate out of Compliance

The 3,556 fleets operating out of compliance are assumed to continue operating until they are cited by the local air districts or come into compliance through natural equipment turnover.

v. Box 5 – Enforcement Action

All fleets operating out of compliance risk enforcement actions each year. The probability of enforcement increases each year as the number of fleets operating out of compliance decreases as a result of the previous year's enforcement and by fleets coming into

compliance through natural turnover.

vi. Box 6 – No Enforcement Action

Non-compliant fleets that continue to operate have a low probability of being cited, therefore, most of these fleets will loop through Box 5 (Enforcement Action?), Box 6 (No Enforcement Action), and then back to Box 4 (Operate out of Compliance).

vii. Box 7 – Enforced Upon

The model randomly selects 250 fleets that would be cited each year while the remaining fleets continue to operate out of compliance. These 250 fleets would then pay the fine, and pay to come into compliance or would go out of business.

viii. Box 8 – Pay a Fine

All fleets that are cited are assumed to incur fines. A fleet will be subject to fines equal to $365,000 per year out of compliance or the fleet value, whichever is lower. The majority of fleets (90 percent) have lower values than $365,000 times the number of years out of compliance, so fines are typically equivalent to the fleet value. After paying fines, the model determines fleet behavior by assuming the fleet would either go out of business or come into compliance.

ix. Box 9 – Go Out of Business

ARB analyzed fleet registration activity after the 2013 fleet average standards became effective to identify fleets that went out of business in response to the standards. Staff defined the fleets that potentially went out of business due to not being able to meet the 2013 fleet average standards as those whose engine registrations were active in January 2012 but inactive or expired in either January 2013 or 2014. A baseline out of business rate was also identified for other years not affected by the 2013 fleet average standards, and was subtracted from the out of business rate observed immediately following implementation of the 2013 fleet average standards.

The cost to comply with the 2013 fleet average standards was much lower than the estimated cost of complying with the 2020 fleet average standards. For this reason, the rate of going out of business was scaled up linearly, proportional to the relative compliance costs in 2013 versus 2020. Compliance costs in 2013 were obtained from the 2004 ATCM Initial Statement of Reasons (ISOR)[19] then adjusted to 2016 dollar values based on the inflation rate and were estimated to be approximately 17 times lower than the total estimated compliance costs required to meet the 2020 fleet average standards. The U.S. dollar experienced an average inflation rate of 2.08 percent per year between 2002[20] and 2016. Table 3 presents the observed out of business rate in 2020 by fleet size, which is estimated as the observed 2013 out of business rate scaled by the cost differential between the 2013 and 2020 standards.

[19] ISOR 2004, https://www.arb.ca.gov/regact/porteng/isor.pdf
[20] Note:This is the year used in the 2004 ATCM cost analysis

Table 3: Going Out of Business Rates

Fleet Size (number of engines)	2013 Percent Out of Business (observed)	Cost Differential between 2020 and 2013	2020 Percent Out of Business (projected)
1	0.536%	17	9.11%
2	0.771%	17	13.11%
3	1.068%	17	18.16%
4	3.046%	17	51.78%
5	1.724%	17	29.31%
6	2.632%	17	44.74%
7	0%	17	0.00%
8	1.923%	17	32.69%

Fleets with over eight engines were not observed to go out of business in response to the 2013 fleet average standards. Therefore, all fleets enforced upon with more than eight engines are assumed to come into compliance with the 2020 fleet average standards.

The out of business rates in Table 3 show relatively high variability among fleet sizes because of the low number of fleets in each size bin. The actual behavior among fleets is unlikely to follow these exact patterns. However, behavior among fleets of similar sizes may potentially be similar. To reduce variability, ARB aggregated the out of business rates into bins corresponding to fleets with 1-3 engines and fleets with 4-8 engines. Weighting the average by the number of fleets in each fleet size bin gives:

Fleets with 1-3 engines:
Weighted Average 1/1/2013 out of business rate: 0.646%
Projected 1/1/2020 out of business rate (x17): 10.98%

Fleets with 4-8 engines:
Weighted Average 1/1/2013 out of business rate: 2.144%
Projected 1/1/2020 out of business rate (x17): 36.45%

The 250 fleets randomly selected to be enforced upon annually were then partitioned by the number of engines in the fleet: 1-3, 4-8, and more than 8. Within these bins, fleets were then organized by highest compliance cost to lowest compliance cost. The BAU assumes that the top 10.98 percentile of 1-3 engine fleets, by compliance cost, subject to an enforcement action will go out of business. Similarly, the top 36.45 percentile of 4-8 engine fleets, by compliance cost, subject to an enforcement action will also go out of business. None of the fleets with more than 8 engines are modeled as going out of business.
The predicted out of business rates is based on limited registration data in PERP that does not include the fleets' financial information. The going out of business rates are estimates subject to a high degree of uncertainty.

x. Box 10 – Come into Compliance (late)

The remaining fleets of the list of 250 enforced upon each year that do not go out of business using the criteria in section ix above are assumed to come into compliance with the 2020 fleet averaging standards. These fleets incur costs to pay fines and purchase new equipment.

xi. Box 11 – Come into Compliance (late)

Fleets will follow this compliance path if they operate in non-compliance when the 2020 fleet average standards become effective, and continue to operate out of compliance until they are compliant with the standards through normal equipment replacement purchasing habits.

c. BAU Results

The BAU analysis iteratively identifies fleet behavior regarding compliance in response to the 2020 fleet average standards. Of the 4,473 total registered fleets, 883 are expected to already be in compliance and 34 are expected to pay to come into compliance in time for the 2020 fleet average standards. This leaves 3,556 fleets (79 percent) that are projected to operate out of compliance with the 2020 fleet average standards. Either these fleets will come into compliance over time through natural turnover or enforcement, or they will go out of business after enforcement actions. Limited enforcement resources means few non-compliant fleets come into compliance over time, leading to higher emission levels than anticipated in the 2004 ATCM.

After accounting for each specific fleet decision making pathway, the BAU analysis provides the annual costs incurred by businesses (compliance costs and enforcement fines) as well as emissions of diesel PM (PM2.5) and NOx. Direct costs for the Portable Regulatory Amendments (Section C) as well as changes in emissions were calculated relative to this BAU scenario.

5. Major Regulation Determination

The Portable Regulatory Amendments are a major regulation because the estimated direct cost savings of the proposal exceeds $50 million in 2026, which is within a 12-month period after full implementation. The Portable Regulatory Amendments will be fully implemented January 1st 2029. Direct costs and cost savings are explained in the Direct Cost section (Section C) of this document.

6. Public Outreach and Input

ARB developed the Portable Regulatory Amendments through a robust public process involving government and industry stakeholders. ARB solicited participation from CAPCOA (California Air Pollution Control Officers Association), which is the association of air pollution control officers from all 35 local air quality agencies located throughout California. To support the development of the Portable Regulatory Amendments, CAPCOA formed a subcommittee of seven CAPCOA members that actively participated in the regulatory development process. ARB also participated in separate meetings with the California Department of Transportation

(CalTrans) which has a large fleet of portable engines registered in PERP and was concerned about meeting the 2017 fleet requirements.

ARB conducted eight public workshops on the Portable Regulatory Amendments. The workshops included affected industry stakeholders, members of the CAPCOA subcommittee, and the public. ARB held workshops throughout the state on March 3, March 8, March 10, June 30, September 13, September 15, September 20, and November 10, 2016. Workshops were webcast to encourage participation by stakeholders who could not attend in person. Following each workshop, and throughout the regulatory development process, ARB received input from and worked with stakeholders on a variety of changes in the Portable Regulatory Amendments. Announcements and materials related to the workshops were publically posted on the ARB website[21] and distributed electronically through a list serve[22] to over 14,000 recipients.

At the first series of workshops in March, ARB invited the public to join a workgroup of interested stakeholders that would help shape the Portable Regulatory Amendments. The resulting workgroup consisted of 48 industry representatives and CAPCOA subcommittee members. ARB held five formal workgroup meetings and many smaller meetings at the request of individual workgroup members. The seven workgroup meetings were conducted on April 19, 2016; May 4, 2016; June 9, 2016; August 17, 2016; October 26, 2016; March 8, 2017; and May 16, 2017. The Portable Regulatory Amendments, including alternatives, were directly shaped by stakeholder comments and suggestions.

7. Description of the Portable Regulatory Amendments

The Portable Regulatory Amendments provide more flexibility for fleets to meet the ATCM, update and simplify the fleet average standards, and improve enforcement capability.

Under the Portable Regulatory Amendments, small fleets[23] and large fleets[24] will have different compliance obligations. Small fleets, which represent 75 percent of PERP fleets, will be required to meet an engine tier phase-out schedule which provides deadlines by which certain tier engines are no longer allowed to be registered. This metric is simple to understand and enforce. By comparison, large fleets will have the option to follow an engine tier phase-out schedule or a fleet average emission standard that requires fleets to identify and average emissions among all engines in the fleet. Because each engine has a different emission factor, it is complicated to estimate the average emissions of the fleet. It is also difficult to enforce a fleet average emission standard, because fleets may register engines in different programs (e.g., some in PERP and some in local programs), so identifying all engines that belong to one fleet is not straightforward. However, the fleet average standard provides some flexibility to large fleets, particularly those with a small number of older specialized engines that would be difficult or costly to replace or retrofit.

[21] PERP https://www.arb.ca.gov/portable/perpact/portable-activity.htm
[22] List serve https://www.arb.ca.gov/listserv/listserv_ind.php?listname=portable
[23] Cumulative horsepower of 750 g/bhp-hr or less
[24] Cumulative horsepower of greater than 750 g/bhp-hr

The proposed engine tier phase-out schedule can be found in Table 4. Small fleets will have progressively more restrictive tier phase-out dates between 2020 and 2029. The proposed fleet average standards are presented in Table 5.

Large fleets will be required to declare which option they choose for ARB planning purposes. The proposed fleet average standards delay compliance dates by 7 years in recognition of the cost and technological challenges of meeting the original 2004 ATCM standards, reducing costs to fleets and increase compliance. In addition, large fleets will have the ability to decide which compliance option is most cost effective for their business model, reducing costs.

Table 4: Proposed Engine Tier Phase-Out Schedule

	Engines rated 50 to 750 bhp		
	Large Fleet	***Small Fleet***	
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)	December 31 of the year 17 years after the date of manufacture		

Table 5: Proposed Fleet Average Standards for Large Fleets

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

The Portable Regulatory Amendments were also designed to simplify implementation and enforcement for PERP staff and the districts. Enforcement of tier phase-out schedules will be managed in PERP (for those registered in PERP), and at the local districts (for those permitted by districts), by issuing registrations or permits with expiration dates that match the phase-out dates for the engines. This will be straightforward to enforce, and allows fleets to easily understand the date by which the engine can no longer be registered.
Large fleets that choose the follow the fleet average standards will be required to register all engines in PERP instead of having some engines registered in PERP and some permitted by local air districts. With all engines registered in one location, PERP will be able to track each fleet's average emissions and promptly notify fleets that are out of compliance, thus increasing enforceability and likelihood of compliance.

The tier phase-out concepts were conceived during several discussions between ARB and the local air districts. The concepts come as a response to the difficulties of implementing and enforcing the existing fleet average standards. The idea to shift from a fleet average schedule to a tier phase-out schedule has been well received by all participants in every public workgroup and workshop. Feedback from the regulated community indicates that a tier phase-out schedule is simple to understand, and therefore improves a fleet's ability to plan for equipment replacement and improves the likelihood that fleets will comply.
The dates of the tier phase-out schedule were developed through numerous workgroup meetings and public workshops with the regulated community, local air districts, and ARB. ARB modeled several compliance schedules proposed both internally and by stakeholders to analyze emission reduction rates and to assess annual equipment replacement costs. An average 17 year engine life was ultimately agreed upon by ARB, local air districts, and the regulated community. This schedule will result in emissions reductions that safeguard public health, while remaining economically feasible for fleets to comply with.

The air districts also indicate that a tier phase-out schedule simplifies enforcement of the regulation. Under a tier phase-out schedule, non-compliance can be assessed based on an individual engine's tier, as opposed to the composition of an entire fleet's engines.

B. BENEFITS

The Portable Regulatory Amendments are intended to maximize compliance rates by simplifying implementation for both fleets and ARB while also increasing enforceability, as described above. Because the current ATCM is technologically and economically challenging to meet, many fleets are anticipated to operate out of compliance and some fleets may go out of business. The high non-compliance leads to high emissions which affect the health of individuals in California, operators of the portable equipment, and the environment. The Portable Regulatory Amendments are achievable and enforceable resulting in compliance rates which reduce emissions compared to the BAU, providing benefits to California. Health benefits from the Portable Regulatory Amendments are discussed in the next section.

Figures 2 and 3 plot the emissions of NOx and PM from portable engines under the BAU and Portable Regulatory Amendments. In 2020, ARB estimates an emission reduction of 0.10 tons per day (tpd) of PM and 2.3 tpd of NOx under the Portable Regulatory Amendments compared to the BAU. 2023 is a key year for attaining the National Ambient Air Quality Standard (NAAQS) for ozone in the South Coast air basin, and ARB estimates emission reductions in 1.2 tpd of NOx compared to the BAU in this year. NOx is a contributor to ozone formation, so the Portable Regulatory Amendments are anticipated to assist in meeting the 2023 NAAQS. These figures show that ARB projects the Portable Regulatory Amendments will prevent emissions of 218 tons of PM and 2,872 tons of NOx between 2017 and 2030 compared to the BAU.

Figure 2: Annual Statewide PM2.5 Emissions (tpd)

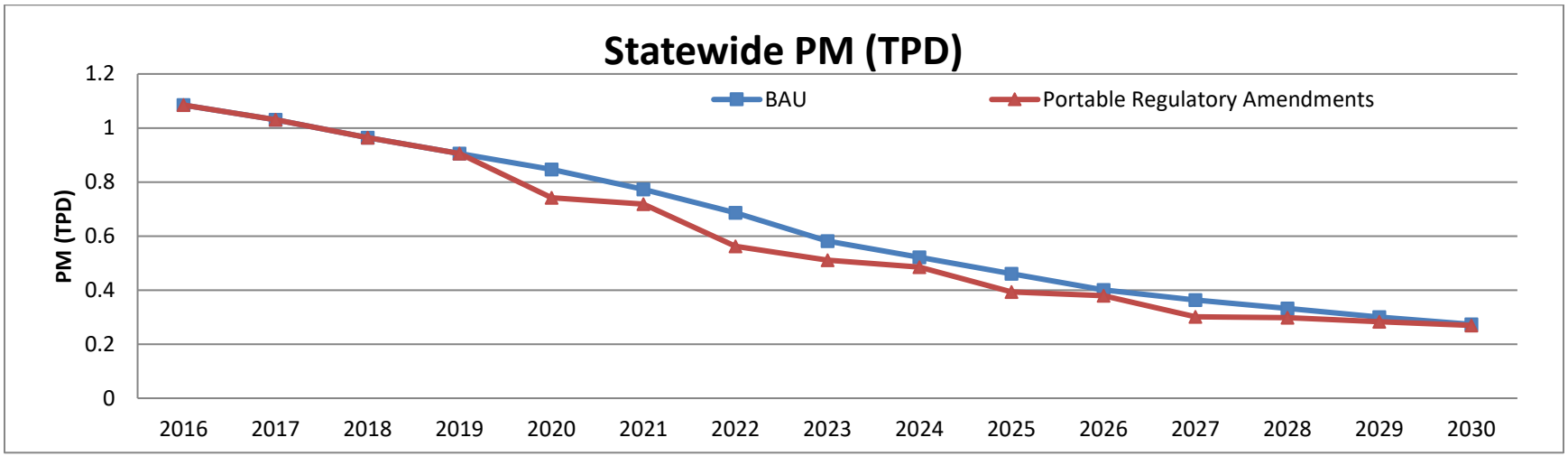
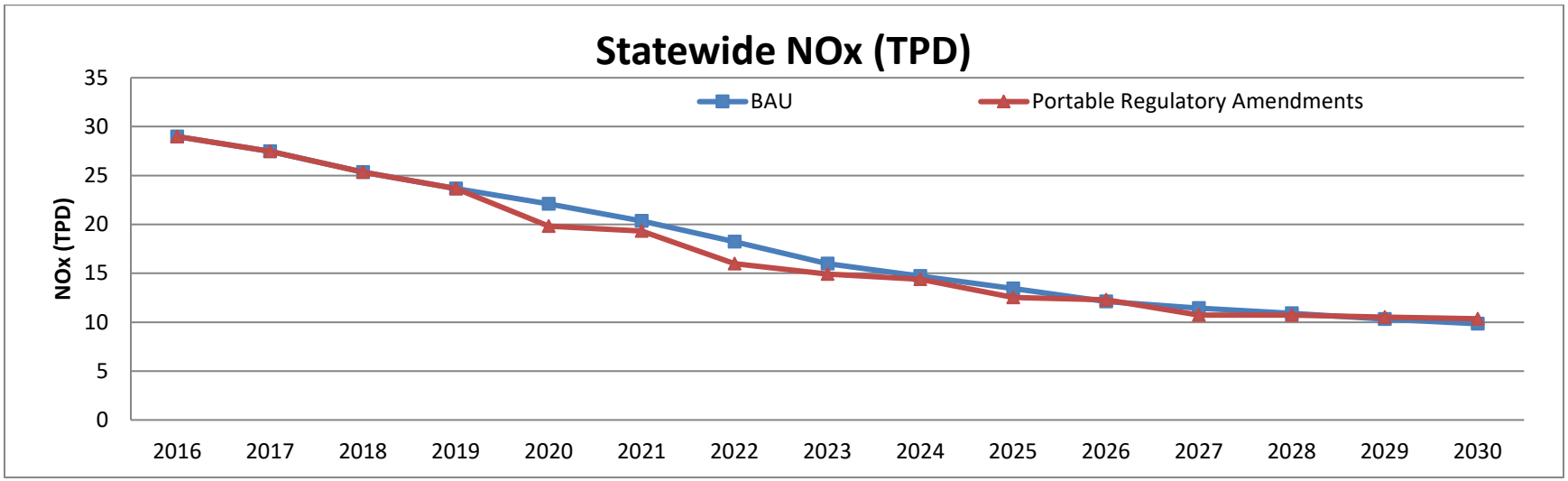


Figure 3: Annual Statewide NOx Emissions (tpd)



1. Benefits to Individuals

The proposed amendments will reduce both PM2.5 and NOx which results in health benefits for individuals in California. For clarity, and because workable data and methodologies were available, ARB is providing monetized health benefits information for certain health benefits identified in this SRIA.[25] These health benefits lead to benefits to individuals, businesses, and government agencies due to fewer premature mortalities, fewer hospital and emergency room (ER) visits, and fewer lost days of work. As part of setting the National Ambient Air Quality Standard for PM, the U.S. EPA quantifies the health risk from exposure to PM,[26] and ARB relies on the same health studies for the estimated of health impacts resulting from the Portable Regulatory Amendments.

ARB analyzed the health benefits of the Portable Regulatory Amendments associated with five health outcomes: cardiopulmonary[27] mortality, hospitalizations for cardiovascular[28] illness, hospitalizations for respiratory[29] illness, ER visits for respiratory illness, and ER visits for asthma.

These health outcomes were selected because U.S. EPA has identified these as having a *causal* or *likely causal* relationship with exposure to PM2.5.[30] The U.S. EPA examined other health endpoints such as cancer, reproductive and developmental effects, but determined there was only *suggestive* evidence for a relationship between these outcomes and PM exposure, and insufficient data to include these endpoints in national health assessment analyses routinely performed by U.S. EPA.

The U.S. EPA has determined that both long-term and short-term exposure to PM2.5 plays a *causal* role in premature mortality, meaning that a substantial body of scientific evidence shows a relationship between PM2.5 exposure and increased risk of death. This relationship persists when other risk factors such as smoking rates, poverty and other factors are taken into account.[31] While other mortality endpoints could be analyzed, the strongest evidence exists for cardiopulmonary mortality.[32] The greater scientific certainty for this effect, along with the

[25] Health benefit projections are complex, and data quality and methodologies will vary depending on the regulation being analyzed. The approach taken here accordingly may differ from those used in other SRIAs in the future, depending on data and methods available.
[26] U.S. EPA, 2010. Quantitative Health Risk Assessment for Particulate Matter (Final Report). https://www3.epa.gov/ttn/naaqs/standards/pm/data/PM_RA_FINAL_June_2010.pdf
[27] Outcomes related to the heart or lungs
[28] Outcomes related to the heart or blood vessels
[29] Respiratory illness such as chronic obstructive pulmonary disease, and respiratory infections
[30] U.S. EPA, 2010. Quantitative Health Risk Assessment for Particulate Matter (Final Report). https://www3.epa.gov/ttn/naaqs/standards/pm/data/PM_RA_FINAL_June_2010.pdf
[31] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F, 2009. http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=494959
[32] U.S. EPA. Integrated Science Assessment (ISA) for Particulate Matter (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F, 2009. http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=494959

greater specificity of the endpoint, leads to an effect estimate for cardiopulmonary deaths that is both higher and more precise than that for all-cause mortality.[33]

The U.S. EPA has also determined a *causal* relationship between non-mortality cardiovascular effects and short and long-term exposure to PM2.5, and a *likely causal* relationship between non-mortality respiratory effects (including worsening asthma) and short and long-term PM2.5 exposure.[34] These outcomes lead to hospitalizations and ER visits, and are included in this analysis.

In general, health studies have shown that populations with low socioeconomic standing are more susceptible to health problems from exposure to air pollution.[35,36] However, the models currently used by U.S. EPA and ARB do not have the granularity to account for this impact. The location and magnitude of projected emission reductions resulting from the Portable Regulatory Amendments are not known with sufficient accuracy to account for socioeconomic impacts, and an attempt to do so would produce uncertainty ranges so large as to make conclusions difficult. ARB acknowledges this limitation.

a. Health Modeling Results

i. Health Outcomes

Table 6 shows the avoided health incidence as a result of the proposed amendments for 2017 through 2030 by California air basin. Values in parenthesis represent the 95 percent confidence intervals of the central estimate. Implementation of the proposed amendments will reduce overall emissions of PM2.5 and NOx, and will lead to a net statewide health benefit.

The majority of health benefits are concentrated in the South Coast Air Basin, with minor health benefits distributed among other regions. As discussed in the attachment to this SRIA, the projections of the spatial distribution of emission reductions from the Portable Regulatory Amendments contains high uncertainty which is not accounted for in the 95 percent confidence intervals.

[33] Estimate of Premature Deaths Associated with Fine Particle Pollution (PM2.5) in California Using a U.S. Environmental Protection Agency Methodology. Air Resources Board, 2010. https://www.arb.ca.gov/research/health/pm-mort/pm-report_2010.pdf

[34] Integrated Science Assessment (ISA) for Particulate Matter. U.S. EPA. (Final Report, Dec 2009). U.S. Environmental Protection Agency, Washington, DC, EPA/600/R-08/139F, 2009. http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=494959

[35] Krewski et al. (2009) Extended Follow-Up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality. Health Effects Institute Research Report 140. https://ephtracking.cdc.gov/docs/RR140-Krewski.pdf.

[36] Gwynn, R.C., Thurston, G.D. (2001) The burden of air pollution: impacts among racial minorities. Environmental Health Perspectives; 109(4):501–6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240572/

Table 6: Cumulative Regional and Statewide Avoided Health Incidences from 2017 to 2030

Air Basin	Avoided Premature Mortality	Avoided Hospitalizations	Avoided ER Visits
Great Basin Valleys	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Lake County	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Lake Tahoe	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Mojave Desert	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)
Mountain Counties	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
North Central Coast	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
North Coast	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Northeast Plateau	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
Sacramento Valley	4 (3 - 4)	1 (0 - 1)	1 (1 - 2)
Salton Sea	0 (0 - 1)	0 (0 - 0)	0 (0 - 0)
San Diego County	2 (1 - 2)	0 (0 - 1)	1 (0 - 1)
San Francisco Bay	11 (8 - 13)	2 (0 - 4)	5 (3 - 6)
San Joaquin Valley	0 (0 - 0)	0 (0 - 0)	0 (0 - 0)
South Central Coast	1 (0 - 1)	0 (0 - 0)	0 (0 - 0)
South Coast	31 (24 - 38)	4 (1 - 10)	13 (8 - 18)
Statewide	38 (30 - 46)	6 (1 - 13)	16 (10 - 22)

ii. Cost Savings from Health Benefits

In accordance with U.S. EPA practice, health outcomes are monetized by multiplying incidence by a standard monetary value derived from economic studies.[37] The valuations per incident are included in Table 7.[38] The valuation for avoided premature mortality is based on estimates of individual's willingness to trade money for reductions in mortality risk.[39] This willingness to pay for avoided premature mortality is a statistical construct and does not represent an estimate of how much any single individual would be willing to pay to prevent a certain death of any particular person,[40] nor does it consider any specific costs associated with mortality such as hospital expenditures. While the valuation associated with reductions in premature mortality is an important benefit of the proposed amendments, the valuation used to monetize

[37] U.S. Environmental Protection Agency, 2010. "Appendix B: Mortality Risk Valuation Estimates, Guidelines for Preparing Economic Analyses." EPA 240-R-10-001. National Center for Environmental Economics, Office of Policy Economics and Innovation. Washington, DC. December. Available at: http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0568-22.pdf/$file/EE-0568-22.pdf. As discounting is not used for costs in this analysis, monetized health savings are not discounted to maintain consistent methodology.

[38] Health benefit projections are complex, and the analyses, data quality, and methodologies will vary depending on the pollutant and exposures being analyzed. The approach taken here accordingly may differ from those used in other SRIAs in the future, depending on the information available.

[39] U.S. Environmental Protection Agency Science Advisory Board (U.S. EPA-SAB). 2000. "An SAB Report on EPA's White Paper Valuing the Benefits of Fatal Cancer Risk Reduction." EPA-SAB-EEAC-00-013. July. Available at: http://yosemite.epa.gov/sab%5CSABPRODUCT.NSF/41334524148BCCD6852571A700516498/$File/eeacf013.pdf

[40] U.S. Environmental Protection Agency. Mortality Risk Valuation – What does it mean the place a value on a life? Accessed 7/2017. https://www.epa.gov/environmental-economics/mortality-risk-valuation#means

the benefit does not easily lend itself to macroeconomic modeling. The benefit associated with premature mortality is reported here, but is not included in macroeconomic modeling (Section D).

Unlike premature mortality valuation, the valuation for avoided hospitalizations and ER visits are based on a combination of typical costs associated with hospitalization and the willingness of surveyed individuals to pay to avoid adverse outcomes that occur when hospitalized. These include hospital charges, post-hospitalization medical care, out-of-pocket expenses, and lost earnings or both individuals and family members, lost recreation value, and lost household production (e.g., valuation of time-losses from inability to maintain the household or provide childcare).[41] Because these are most closely associated with specific cost-savings to individuals and the healthcare system, monetized benefits from avoided hospitalizations and ER visits are included in macroeconomic modeling (Section D). Health benefit projections are complex, and the analyses, data quality, and methodologies will vary depending on the pollutant and exposures being analyzed. The approach taken here accordingly may differ from those used in other SRIAs in the future, depending on the information available.

Table 7: Estimated Valuation per Incident for Avoided Health Outcomes

Outcome	Cost-Savings per Incident
Avoided Premature Mortality	$8,629,716
Avoided Acute Respiratory Hospitalizations	$45,221
Avoided Cardiovascular Hospitalizations	$51,844
Avoided ER Visits	$742

The total statewide valuation as a result of avoided health outcomes is summarized in Table 8 below. The spatial distribution of the valuation follow the distribution of emission reductions and avoided health outcomes, therefore most will occur in the South Coast Air Basin.

[41] Chestnut, L. G., Thayer, M. A., Lazo, J. K., and Van Den Eeden, S. K.. 2006. "The Economic Value of Preventing Respiratory And Cardiovascular Hospitalizations." Contemporary Economic Policy, 24: 127–143. doi: 10.1093/cep/byj007 Available at: http://onlinelibrary.wiley.com/doi/10.1093/cep/byj007/full

Table 8: Estimated Statewide Cumulative Valuation from Avoided Health Outcomes as a Result of the Proposed Amendments for 2017 to 2030

Outcome	Cumulative Cost-Savings
Avoided Premature Mortality	$327,916,887
Avoided Hospitalizations	$273,454
Avoided ER Visits	$11,899

b. Qualitative Discussion of Other Health Outcomes

i. Occupational Exposure

The California Division of Occupational Safety and Health (Cal/OSHA) does not have a permissible exposure limit (PEL) specifically for diesel PM. Still, ARB recognizes that workers that use portable diesel-powered equipment, such as power generators, pumps, compressors, pile-driving hammers, welders, cranes, wood chippers and dredgers, may be at risk to occupational diesel particulate matter exposure. Studies have shown occupational exposure to be lower when diesel engines meet more stringent emissions standards.[42] The proposed amendments result in lower emissions from current conditions, which will reduce occupational exposure to diesel PM. This effect cannot be quantified due to lack of data on the typical occupational exposure for these types of portable equipment.

ii. Cancer Mortality and Cancer Risk

While U.S. EPA has considered monetizing cancer mortality at a 1.5 times factor compared to other causes of mortality,[43] U.S. EPA has not used this factor to monetize cancer mortality in recent regulatory impact analyses. Following U.S. EPA, ARB does has does not monetize cancer mortality. A small reduction in cancer mortality could occur as a result of diesel PM emission reductions from the proposed amendments.

To estimate the potential decrease in health risk associated with greater emissions reductions under the Portable Regulatory Amendments, ARB estimated the cancer risk from the diesel PM emissions of portable equipment. This was determined by identifying the cancer risk from ambient concentrations of diesel PM multiplied by the proportion of diesel PM that can be attributed to portable engines. Most major sources of diesel PM emissions are often located near highly populated areas. Because of this, elevated PM levels are mainly an urban problem, with large numbers of people exposed to higher PM concentrations, resulting in greater health consequences compared to rural areas. The South Coast Air Basin has the greatest number of diesel PM sources and, therefore, represents the majority of potential cancer risk statewide.

[42] Lee, K.H., Jung, H.J., Park, D.U., Ryu, S.H., Kim, B., Ha, K.C., et al. (2015) Occupational Exposure to Diesel Particulate Matter in Municipal Household Waste Workers. https://doi.org/10.1371/journal.pone.0135229

[43] "Valuing Mortality Risk Reductions for Environmental Policy: A White Paper." U.S. Environmental Protection Agency. 2010c. Office of Policy, National Center for Environmental Economics Available at: https://yosemite.epa.gov/ee/epa/eerm.nsf/vwan/ee-0563-1.pdf/$file/ee-0563-1.pdf

Table 9 outlines the cancer risk associated with estimated PM emissions from portable equipment in the South Coast Air Basin under the BAU and the projected emissions from the Portable Regulatory Amendments over time.

Table 9: Projected South Coast Air Basin-Wide Cancer Risk from Portable Equipment Diesel PM (Chances per Million)

Year	BAU	Portable Regulatory Amendments
2012	48	48
2017	35	35
2020	28	25
2021	26	24
2023	21	18
2027	13	11
2030	10	9

Table 9 shows that the Portable Regulatory Amendments would reduce the potential cancer risk associated with portable diesel engine emissions in the South Coast Air Basin compared to the BAU.

2. Benefits to Typical Businesses

The Portable Regulatory Amendments provide additional time and flexibility to meet the standards, which will allow fleets to operate in compliance and save potential fines from enforcement. Cost-savings are discussed in detail in Section C of the document, while additional discussion of the indirect and induced impacts on businesses will be discussed in the Macroeconomic Impact section.

Reduced emissions will likely reduce occupational exposure for portable equipment operators, as well as other workers near this equipment. This reduced exposure may result in fewer lost work days due to health issues and better productivity. The improved quality of life may help businesses improve the recruitment and retention of the workers.

3. Benefits to Small Businesses

The Portable Regulatory Amendments provide small fleets, which represent about 78 percent of fleets registered in PERP, additional time to meet the proposed tier phase-out requirements, greatly simplify fleet management, and therefore reduce overall compliance costs for the regulated community. The vast majority of these small fleets, defined as fleets with no more than 750 total horsepower, are also small businesses. For the Portable Regulatory Amendments, ARB defines a small business in the same way it defines a small fleet. It is possible some small fleets could go out of business without the Portable Regulatory Amendments. Lower costs, more time to comply, and simplified compliance are anticipated to

eliminate small fleets going out of business. Small businesses will enjoy the same benefits as typical businesses for reductions in occupational exposure.
Cost-savings are discussed in detail in Section C, while additional discussion of the indirect and induced impacts on businesses will be discussed in the Macroeconomic Impact section (Section D).

C. DIRECT COSTS

1. Cost Analysis

The inputs to the direct cost estimation are outlined in the following section. Direct costs include equipment costs, diesel exhaust fluid (DEF) costs, and increased registration fees. Direct cost-savings include decreased enforcement fines compared to the BAU, where high non-compliance is anticipated. Because fleets are expected to comply with the Portable Regulatory Amendments, enforcement fines that would be incurred under the BAU are no longer incurred, resulting in a cost-savings.

a. Equipment Costs

Equipment replacement represents the majority of costs of the Portable Regulatory Amendments. During the Portable Regulatory Amendments process, ARB collected data on recently sold or listed for sale new and used portable equipment using cost data for equipment provided by stakeholders, as well as a variety of online sources. A cost curve was developed based on data from more than 230 pieces of portable equipment with various engine tiers, horsepower, and age, representing generators, compressors, and pumps. The cost curve was then used in ARB's equipment turnover model to calculate equipment replacement cost on a per unit basis by taking the cost of newly purchased equipment required and subtracting it from the existing equipment's resale value. Any equipment costs in the BAU are then subtracted to identify costs as a result of the Proposed Regulatory Amendments only.

Calculating equipment replacement costs requires estimates of the compliance option large fleets would select, fleet purchasing habits, and fleet decision-making, as described in the next sections.

i. Fleet Compliance Option Selection

To determine the compliance option large fleets would select (either tier phase-out or fleet average standard), individual fleets were evaluated on the characteristics of the engines in their fleet. Fleets with one or more engine at least twelve years old and with a relatively low fleet emission average are predicted to follow the fleet average schedule. A low fleet emission average already puts these fleets on track to comply with the proposed 2020 fleet average standard, while allowing these fleets to retain older, potentially specialized, pieces of equipment that cannot be replaced due to technological or economic constraints.

ARB expects large fleets with relatively high fleet average emissions would likely follow the tier phase-out schedule, due to the later compliance dates for the tier phase-out relative to the fleet

average option. Under the phase-out schedule, large fleets may extend the life of their equipment while staying compliant. This may be attractive to fleets with a high proportion of Tier 3 engines that do not meet the proposed 2020 fleet average standard. The tier phase-out schedule allows these Tier 3 engines to be operated in California until 2025, 2027 or 2029, depending on the fleet size and year of engine manufacture.

Using these criteria, about 67 percent of large fleets are projected to select the tier phase-out option and 33 percent of large fleets are projected to select the fleet average standard option.

ii. Fleet Purchasing Habits

ARB assumes each fleet will keep the average age of their equipment steady across all years unless compliance with a standard forces them to accelerate turnover, bringing the average equipment age down for that year. If a fleet must remove and replace equipment to become compliant with an upcoming fleet standard, this analysis assumes a fleet will sell the oldest piece of equipment and replace it with a newer engine of equal horsepower and equipment type. The tier of the engine is strongly correlated to the age of the engine. In most cases, removing the oldest engine in a fleet also means removing the highest emitting engine in that fleet. Equipment costs are amortized over a 5-year period at an 8 percent interest rate based on stakeholder feedback of typical financing conditions.

iii. Fleet Decision-Making Process

Assumptions regarding fleet decision making were developed using eleven years of PERP registration data that contains detailed information on approximately 4,400 fleets in California. This data includes years when the current fleet standards became effective, providing insight on historic fleet response to meeting standards similar to the Portable Regulatory Amendments. Based on this data, ARB assumes that fleets maintain a constant total horsepower throughout the Portable Regulatory Amendments. In addition, PERP data from 2005 through 2016 was used to estimate each fleet's average engine age and horsepower.

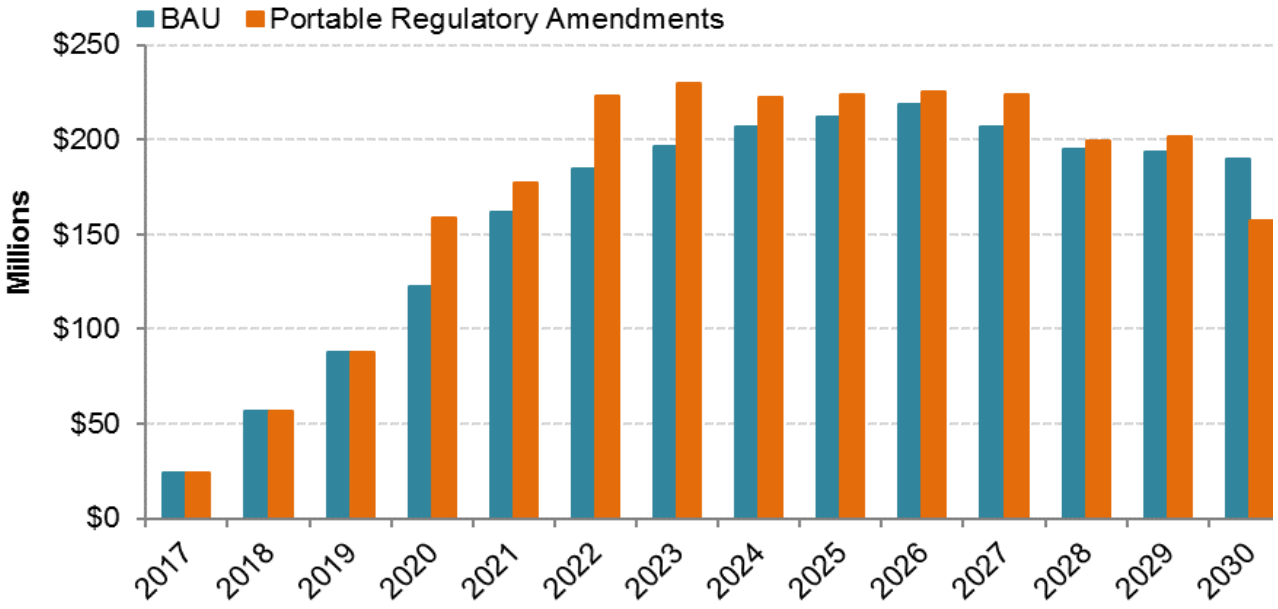
iv. Equipment Cost Results

The historical PERP registration inventory data discussed above was used to populate an equipment turnover model designed by ARB's emissions modeling team. The model predicts when engines are replaced by newer engines for a fleet to become compliant with a given compliance scenario. In this analysis two scenarios were run, the BAU and the Portable Regulatory Amendments.

Under the BAU most fleets are assumed to operate out of compliance, making costs under the BAU very low for most fleets. For this reason, equipment replacement costs in the Portable Regulatory Amendments are a net cost increase to fleets in most years. On average, state-wide equipment costs for all fleets from 2017 through 2030 are estimated to be approximately $10 million per year.

Figure 4 shows the estimated annual amortized equipment replacement cost under the BAU and under the Portable Regulatory Amendments. Figure 4 illustrates the marginally higher annual equipment costs under the Portable Regulatory Amendments relative to the BAU for most years. Annual equipment costs under the Portable Regulatory Amendments are included in the summary at the end of this section, Table 12.

Figure 4: Estimated Annual Equipment Replacement Cost for BAU and the Portable Regulatory Amendments



b. Registration Costs

The Portable Regulatory Amendments include a registration fee increase that will impose a direct, on-going cost to businesses that register engines in PERP. The proposed fees will also result in additional revenue to the State and all 35 air districts who receive a portion of the registration fees. Registration costs are estimated by multiplying the total registration fee increase by the estimated numbers of equipment for both initial and renewal registrations (which renew every three years). Table 10 outlines the current registration fees under the BAU and proposed registration fees under the Portable Regulatory Amendments. The fiscal impacts for state and local air districts are described in the Fiscal Impact section (Section F).

Table 10: Changes to On-Going Registration Costs

Initial Registration (3 year registration)			
Cost Type	BAU	Portable Regulatory Amendments	Change in Cost
Total for New Registration	**$620**	**$805**	**$185**
Registration Renewal (3 year registration)			
Cost Type	BAU	Portable Regulatory Amendments	Change in Cost
Total for Renewal	**$575**	**$740**	**$165**

ARB used the equipment turnover model to forecast the number of engines that will be newly registered or renewed each year as a result of the BAU and the Portable Regulatory Amendments. The cost to industry for initial registrations was calculated by multiplying the initial registration fee by the estimated number of initial registration applications processed in a given year. The cost to industry for renewals was calculated by multiplying the renewal cost by the number of registration renewals projected in a given year. The following equation was used to calculate the number of renewals, in any given year:

$$PERP\ Renewals\ per\ Year = \frac{TNE - IR}{3}$$

Where TNE represents the total number of engines in PERP, which the model holds constant, and IR represents the number of initial registrations in a given year as estimated by the equipment turnover model. To determine the number of renewals each year, the annual initial registrations (IR) are subtracted from the total number of engines (TNE) and divided by three to account for the three-year registration cycle. The projected annual numbers of initial registrations and renewals under the BAU and the Portable Regulatory Amendments are presented in Table 11.

Registration costs in the Portable Regulatory Amendments lead to higher fees between 2017 and 2030, even if fewer engines are registered in a given year. 2020 is predicted to be a peak year for registration fees due to the first set of compliance standards in both the tier phase-out and fleet average standard compliance dates. The total increase in registration fees for the industry in 2017 through 2030 is estimated at $26,776,748, or approximately $1.9 million per year. Annual registration fee cost increases under the Portable Regulatory Amendments are included in the summary at the end of this section, Table 12.

Table 11: Projected Number of Renewals and Initial Registrations by Year

	BAU		Portable Regulatory Amendments		Difference (Portable Regulatory Amendments – BAU)	
	# Newly Registered Engines	Renewals	# Newly Registered Engines	Renewals	# Newly Registered Engines	Renewals
2017	1733	9442	1733	9442	0	0
2018	2358	9234	2358	9234	0	0
2019	1858	9401	1884	9392	26	-9
2020	2084	9325	6195	7955	4111	-1370
2021	2570	9163	848	9737	-1722	574
2022	2895	9055	3599	8820	704	-235
2023	2526	9178	2599	9154	73	-24
2024	2456	9201	941	9706	-1515	505
2025	1955	9368	2176	9295	221	-74
2026	1967	9364	637	9808	-1330	443
2027	1104	9652	2022	9346	918	-306
2028	922	9713	328	9911	-594	198
2029	906	9718	678	9794	-228	76
2030	639	9807	431	9876	-208	69

c. Diesel Exhaust Fluid Costs

Currently, all Tier 4 engine manufacturers have opted to use Selective Catalytic Reduction (SCR), which requires Diesel Exhaust Fluid (DEF) to be sprayed on a catalyst to break apart NOx into inert nitrogen and water to reduce NOx emissions. DEF is a urea-water mixture that is consumed by the SCR at a rate proportional to the consumption rate of diesel fuel. In order to calculate how much DEF will be consumed in any given year under the BAU and Portable Regulatory Amendments, ARB calculated the amount of diesel fuel annually consumed by Tier 4 engines. The equipment turnover model projects the number of Tier 4 engines operating in California for each year starting in 2016 under the BAU scenario and under the Portable Regulatory Amendments scenario.

The amount of DEF required under the BAU and the Portable Regulatory Amendments is based on the dosing rate, the DEF to diesel consumption ratio. The top three engine manufacturers' websites[44-34] show an average dosing rate between 1 and 5 percent. To estimate the highest cost impact, 5 percent is used as the dosing rate. The annual DEF consumption rate is calculated by multiplying the annual fuel consumption rate by the 5 percent dosing rate.

[44] Cummins Tier 4 Technology https://www.cdc.gov/niosh/mining/UserFiles/workshops/dieselaerosols2012/NIOSHMVS2012Tier4TechnologyReview.pdf

The cost of DEF in dollars per gallon is used to calculate the annual cost to all fleets as a result of the Portable Regulatory Amendments. Most equipment manufacturers purchase DEF in 55 gallon drums, for which the cost is estimated at $2.88 per gallon.[45] It is assumed that this cost remains constant for the timeframe of this analysis.

The Portable Regulatory Amendments result in DEF cost increases in some years, and cost-savings in other years compared to the BAU. This is because of the relative horsepower of tier 4 engines that are assumed to be in use in each scenario. The total increase in DEF costs for the industry in 2017 through 2030 is estimated at $3.5 million dollars, which is spread across all fleets. Annual DEF cost changes under the Portable Regulatory Amendments are included in the summary at the end of this section, Table 12.

d. Enforcement Cost-Savings

The Portable Regulatory Amendments assume all fleets will be compliant resulting in no enforcement penalties, while the BAU projects high levels of non-compliance with the 2020 fleet standards requiring enforcement and assuming penalties assessed. As a result fleets that would be enforced upon in the BAU will experience an enforcement penalty cost-savings under the Portable Regulatory Amendments. The total enforcement cost-savings for 2017 through 2030 is estimated at $417 million dollars or approximately $42 million per year on average. Annual enforcement cost-savings under the Portable Regulatory Amendments are included in the summary at the end of this section, Table 12.

These enforcement cost-savings to fleets represent a loss of revenue to districts that would have otherwise collected the enforcement fees, and this result is discussed in the Fiscal Impact Section (Section F). For reasons explained in section A.4.d.ii., these enforcement fines are likely an overestimate of actual fines. Mitigating factors reduce fine amounts for each citation by unique amounts for each fleet based on each fleet's economic situation and the nature of the violation.

e. Total Costs

The annual and total cost or cost-savings for each of the items listed above is summarized in Table 12. Overall, the Portable Regulatory Amendments are expected to result in a direct cost savings of $233 million from 2017 through 2030. In earlier years, fleets experience an additional cost compared to the BAU, as a result of more fleets coming into compliance. Cost-savings in later years are primarily driven by enforcement penalty cost-savings. These cost-savings are very difficult to predict, and have high uncertainty.

[45] Diesel Exhaust Fluid Drum https://www.google.com/search?q=def+55+gallon+drum&ie=utf-8&oe=utf-8#q=def+55+gallon+drum&tbm=shop

Table 12: Annual and total direct costs or cost-savings to fleets as a result of the Portable Regulatory Amendments for 2017 through 2030.

Year	Equipment	DEF Fluid	Registration or Renewal Fees	Enforcement Penalty	Net Impact
2017	$0	$2,268,436	$1,878,590	$0	**$4,147,026**
2018	$5,660	$3,594	$1,959,840	$0	**$1,969,094**
2019	$82,722	$11,633	$1,909,429	$0	**$2,003,784**
2020	$35,927,239	$1,420,963	$4,219,389	$0	**$41,567,591**
2021	$15,338,318	$471,077	$1,025,922	-$27,072,423	**-$10,237,106**
2022	$38,405,258	$1,307,273	$2,422,572	-$32,612,473	**$9,522,630**
2023	$33,311,850	$725,877	$2,022,394	-$47,070,455	**-$11,010,334**
2024	$15,560,855	-$248,486	$1,126,705	-$44,377,253	**-$27,938,179**
2025	$11,700,638	$292,551	$2,030,864	-$47,370,235	**-$33,346,182**
2026	$6,674,913	-$850,827	$1,166,309	-$52,767,712	**-$45,777,317**
2027	$17,035,556	$12,040	$2,309,214	-$42,429,718	**-$23,072,908**
2028	$4,553,521	-$428,998	$1,441,532	-$31,937,358	**-$26,371,303**
2029	$7,773,920	-$715,506	$1,643,707	-$44,622,943	**-$35,920,821**
2030	-$32,917,280	-$758,564	$1,620,281	-$46,353,613	**-$78,409,176**
Total	**$153,453,169**	**$3,511,063**	**$26,776,748**	**-$416,614,182**	**-$232,873,201**
Annual Average	**$10,960,940**	**$250,790**	**$1,912,625**	**-$41,661,418**	**-$16,633,800**

2. Direct Costs on Typical Businesses and Small Businesses

For most years under the Portable Regulatory Amendments fleets see an increase in registration fees, increase in equipment costs, increase in DEF costs, and a decrease in enforcement penalties compared to the BAU (Table 12). Enforcement penalty cost-savings are only incurred by the subset of fleets that were assumed not to comply in the BAU, who were subsequently enforced upon. While the BAU used specific assumptions to identify fleets enforced upon each year, these assumptions have high uncertainty. It is difficult to predict which specific fleets would have been enforced upon in the BAU, and therefore enjoy cost-savings under the Portable Regulatory Amendments, so it is difficult to distribute costs and cost-savings among small and large fleets. In addition, the magnitude of enforcement penalty cost-savings contains high uncertainty.

For this reason, the cost-savings to a typical business and a small business are estimated together by dividing the net impact of the Portable Regulatory Amendments from 2017 through 2030 buy the total number of fleets. There are currently 4,473 fleets registered in PERP, and about 78 percent of these are small fleets, the majority of which are also small businesses. Dividing the net cost-savings of approximately $233 million by 4,473 gives an average cost-savings per fleet of $52,000 from 2017 through 2030, or an annual cost-savings of $3,700 per fleet.

Since enforcement penalty cost-savings contain high uncertainty and only apply to a subset of fleets, it is also illustrative to estimate the potential costs to business excluding this value. The net cost across all fleets for equipment, DEF, and registration and renewal fees from 2017 through 2030 is $184 million. This represents a cumulative cost of $41,000 per fleet over 2017 through 2030, or $2,900 per fleet per year.

3. Direct Costs on Individuals

There are no direct costs to individuals as a result of the Portable Regulatory Amendments. Any indirect or induced impacts on individuals will be discussed further in the Macroeconomic Impact section (Section D). Cost-savings from health benefits to individuals were discussed in the Benefits section (Section B).

D. MACROECONOMIC IMPACTS

1. Methods for Determining Economic Impacts

Regional Economic Models, Inc. (REMI), Policy Insight Plus Version 2.1.1 is used to estimate the macroeconomic impacts of the Portable Regulatory Amendments on the California economy. REMI is a structural economic forecasting and policy analysis model that integrates input-output, computable general equilibrium, econometric and economic geography methodologies.

REMI provides year-by-year estimates of the total impacts of the Portable Engine Amendments, meeting the requirements of the Administrative Procedure Act and its implementing regulations.[46] ARB uses the REMI single-region, 160-sector model with the model Reference case adjusted to reflect the Department of Finance conforming forecast dated June 2017. These forecasts include California population figures, U.S. real GDP forecast, and civilian employment growth numbers.

The Portable Regulatory Amendments are simulated in REMI by adjusting production costs for covered sectors to reflect the change in purchases of portable equipment, the increase in registration costs (adjusted for increased program costs), and the change in costs due to the maintenance of the portable equipment. The years of analysis are 2017 through 2030. These years are used to simulate the Portable Regulatory Amendments through 12 months post full implementation.

2. Inputs of the Assessment

A summary of REMI assumptions follows:

4. Production Cost Changes:
    d. Changes in costs for portable equipment are represented as a production cost increase or decrease to an industry depending upon the year.
    e. Changes in costs for DEF for Tier 4 engines are represented as a production cost increase or decrease to an industry depending upon the year.
    f. Changes in costs for registration and renewals are represented as production costs and are higher in the amendments in all years relative to the BAU.

[46] Gov. Code, §§ 11346.3, 11346.36; 1 Cal. Code Regs., tit. 1 §§ 2000-2004;see also: http://dof.ca.gov/Forecasting/Economics/Major_Regulations/SB_617_Rulemaking_Documents/documents/Order_of_Adoption-1.pdf

g. Changes in enforcement penalties paid due to non-compliance are represented as production costs and are lower in the amendments in all years relative to the BAU.

5. Exogenous Final Demand Changes (changes in the demand faced by final product manufacturers as a result of changes in equipment and maintenance costs):
    c. The manufacturers of portable equipment face increased (or decreased depending upon the year) demand for their products as a result of purchase requirements under the Portable Regulatory Amendments.
    d. The manufacturers of DEF will face increased (or decreased depending upon the year) demand as a result of purchase requirements for the Portable Regulatory Amendments.

6. State and local spending:
    b. In all years, there are estimated increases in State spending due to the increased revenue for registration costs. A portion of the PERP fee is afforded to the State to process and register portable engines and a portion is afforded to the local air districts to implement and enforce the applicable requirements. Additionally, some State agencies and localities are also regulated parties that will change equipment purchases in response to the Portable Regulatory Amendments. The modeling of the costs to State and local entities is discussed in more detail in the next section.
    c. Beginning in fiscal year 2018-19, ARB anticipates 4 positions to provide sufficient full-time staffing resources to implement the Portable Regulatory Amendments and to support PERP and ATCM going forward. These positions are discussed in Section F, Fiscal Impacts.
    d. Compliance rates are anticipated to be higher under the amendments due to decreased costs of compliance and an improved ability to enforce requirements. Increased compliance rates lead to a decrease in state spending due to a decrease in penalties collected from non-compliant fleets.

7. Consumer spending on hospitals
    a. Health benefits, as outlined in Section B.1, result in a decrease in consumer spending for hospitals and other healthcare related services. This is modeled in REMI as a decrease in consumer spending on hospitals, and offset with the consumption reallocation variable, which increases spending in all other consumption categories.

Table 13 contains the REMI input values used to model the Portable Regulatory Amendments. The first two rows of Table 13 include the primary industries, or those that are directly affected by the Portable Regulatory Amendments. The two primary industries each represent 47 percent of the total equipment within the Portable Regulatory Amendments. The third and fourth row in Table 13 include the secondary industries, or those that are indirectly affected by the Portable Regulatory Amendments, discussed in greater detail below.

3. Assumptions and Limitations of the Model

The estimated economic impacts of the Portable Regulatory Amendments are sensitive to assumptions made by ARB. The following list outlines the key assumptions made in estimating the economic impacts for the purposes of modeling the Portable Regulatory Amendments in REMI.

3. The primary impacted industry is broken into the following categories using the North American Industry Classification System (NAICS):
    a. NAICS 5324 (Commercial and industrial machinery and equipment rental and leasing): This NAICS is used for the rental companies that offer portable equipment for rent to individuals and businesses. For this analysis, this portion of the industry is assumed to represent approximately 47 percent of the total equipment.
    b. NAICS 23 (Construction): The non-governmental and non-rental companies are grouped in the construction category. For this analysis, construction is assumed to represent approximately 47 percent of the total equipment.
    c. State Government: Less than 1 percent of currently registered fleets in the PERP database are State government entities.
    d. Local Government: Less than 5 percent of the currently registered fleets in the PERP database are local government entities.
    e. Federal Government: A portion of the currently registered fleets in the PERP database represent federal government entities, including military bases. Costs associated with these fleets are not entered into the analysis as the spending originates outside California. Portable equipment owned by the federal government represents less than 0.5 percent of the total equipment in the analysis.

4. The secondary industries, that manufacture PERP equipment or sell DEF, are broken down into:
    a. NAICS 3331 (Agriculture, construction, and mining machinery manufacturing): As fleet-specific NAICS code information was not available, for simplicity it is assumed that all of the exogenous final demand is associated with the NAICS code representing agriculture, construction, and mining machinery manufacturing.
    b. NAICS 4247 (Petroleum and petroleum products merchant wholesalers): This NAICS represents DEF sales relative to the BAU.
3. All equipment is financed for five years using an 8 percent interest rate. While stakeholders identified varied financing depending upon the equipment type and business size, 8 percent financing represents a conservative estimate.

4. Equipment purchases by State and local government are not modeled in REMI. The REMI model does not adjust tax collection in response to changes in spending. Thus, increased spending by government does not accurately reflect the benefits to the economy when modeled in REMI. State and local government represents less than 6 percent of portable equipment, thus their omission from the analysis is not anticipated to significantly impact the modeling results.

Table 13: REMI Inputs – Annual Cost or Savings for Portable Regulatory Amendments (M$2016)

			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Primary Industries	**Explanation**	**REMI Category**														
Commercial and industrial machinery & equipment rental and leasing (NAICS 5324)		**Production Cost (M$2016)**	$1.95	$0.93	$0.94	$19.58	-$4.82	$4.49	-$5.19	-$13.16	-$15.71	-$21.56	-$10.87	-$12.42	-$16.92	-$36.93
Construction (NAICS 23)		**Production Cost (M$2016)**	$1.95	$0.93	$0.94	$19.58	-$4.82	$4.49	-$5.19	-$13.16	-$15.71	-$21.56	-$10.87	-$12.42	-$16.92	-$36.93
State Government	**Staff resources, fee revenue, enforcement penalty changes**	**State Spending (M$2016)**	$1.88	$2.49	$2.97	$5.27	-$24.99	-$29.14	-$43.99	-$42.20	-$44.29	-$50.55	-$39.07	-$29.44	-$41.93	-$43.68
Secondary Industries	**Explanation**	**REMI Category**														
Agriculture, construction, and mining machinery manufacturing (NAICS 3331)	**Equipment sales**	**Exogenous Final Demand (M$2016)**	$0.00	$0.02	$0.31	$143.12	-$82.21	$92.10	-$20.31	-$70.57	$127.70	-$102.27	$133.47	-$70.15	-$57.71	-$34.76
Petroleum and petroleum products merchant wholesalers (NAICS 4247)	**DEF sales**	**Exogenous Final Demand (M$2016)**	$2.27	$0.00	$0.01	$1.42	$0.47	$1.31	$0.73	-$0.25	$0.29	-$0.85	$0.01	-$0.43	-$0.72	-$0.76

			2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Health Benefits	**Explanation**	**REMI Category**														
Consumer Spending Hospitals	**Health benefits savings**	**Consumer Spending (M$2016)**	$0.00	$0.00	$0.00	-$0.05	-$0.02	-$0.07	-$0.03	-$0.01	-$0.04	-$0.01	-$0.03	-$0.02	-$0.01	$0.00
Consumption Reallocation	**Increased consumption resulting from health benefits savings**	**(M$2016)**	$0.00	$0.00	$0.00	$0.05	$0.02	$0.07	$0.03	$0.01	$0.04	$0.01	$0.03	$0.02	$0.01	$0.00

The input values are rounded to the nearest $10,000.

4. Results of the Assessment

a. California Employment Impacts

As modeled, the Portable Regulatory Amendments would have a small impact on employment growth relative to the BAU scenario. Table 14 shows that the largest impact to employment growth occurs in years 2020 to 2024, compared with the BAU. Decreases in employment in early years are consistent with the higher direct costs to the primary industries as additional purchases of equipment are made. These decreases are likely due REMI's response to increases in production costs by decreasing output and thus decreasing both capital and labor purchases. While the primary industries face cost savings in later years due to decreases in penalties, these savings also result in decreases in state spending due to lower fine revenues. Combined, these two factors to lead to a small increase in employment growth in years 2025 through 2030. Table 14 indicates that the cumulative impact of the Portable Regulatory Amendments on employment growth is negative. However, the overall slowing of growth represents less than 0.01 percent of California's projected employment in all years of the assessment.

Employment impacts are predominantly concentrated in the construction industry, with a slight slowing of growth in response to increased costs to operate their businesses as outlined in Table 15. For the construction sector, the largest decrease in employment growth is -0.01 percent occurring from 2020 through 2023, and this slowing of employment growth is likely due to

the sector's response to changes in costs as shown in most economic indicators. In later years, the construction sector sees an increase in employment growth due to avoided fines. The employment output for commercial and industrial machinery and equipment rental and leasing would suggest that this industry is able to absorb costs more so than others, and are anticipated to see trivial employment impacts as a result of the Portable Regulatory Amendments in early years. This industry also sees small increases in employment in later years that is likely due to decreased penalties. The cumulative impact of the Portable Regulatory Amendments on the primary industries is an increase in employment growth.

Table 14: Estimated Change in Employment Growth Across All California: Industries Relative to the BAU

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
% Change	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Change in Total Jobs	-25	-0	-0	-600	-600	-700	-700	-300	25	0	100	100	0	650

The value in each year is interpreted as the reference year value less the BAU value in that same year. The change in jobs is rounded to the nearest 25.

Table 15: Estimated Change in Employment Growth in California: Primary and Secondary Industries Relative to the BAU

		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Primary Industries															
	Change (%)	0.00%	0.00%	0.00%	-0.01%	-0.01%	-0.01%	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%	0.01%	0.02%
	Change in Jobs	0	0	0	0	0	0	0	0	0	0	5	5	5	5
	Change (%)	0.00%	0.00%	0.00%	-0.01%	-0.01%	-0.01%	-0.01%	0.00%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%
	Change in Jobs	-10	-10	-5	-140	-95	-110	-80	10	75	110	95	90	75	180
Secondary Industries															
	Change (%)	0.00%	0.00%	0.00%	0.68%	-0.38%	0.40%	-0.09%	-0.29%	0.51%	-0.39%	0.50%	-0.25%	-0.20%	-0.11%
	Change in Total Jobs	0	0	0	35	-20	20	-5	-15	25	-20	30	-15	-10	-5

The value in each year is interpreted as the reference year value less the BAU value in that same year. The change in jobs is rounded to the nearest 5.

b. California Business Impacts

The Portable Regulatory Amendments are anticipated to have a small impact on the growth in final product output, referred here as output growth, relative to the BAU. As modeled, fleets would spend slightly more on portable equipment in early years, with intermittent increases in capital expenditures through 2030. Table 16 shows a slowing of growth in output for primary industries in early years when the Portable Engine Amendments are implemented. This is followed by increases in growth in output for the primary industries in later years when industries see cost savings due to decreases in fines. The trends in output growth follow similar patterns to that of the employment values shown in Table 15.

For manufacturers of portable engines, the largest positive impact to output growth are anticipated in 2020, 2022, 2025, and 2027, the years accounting for the largest increases in exogenous final demand, relative to the BAU. The impacts shown in

Table 16 reflect the impact to output growth, categorized by industry, for businesses located in California. According to the REMI modeling results, approximately 90 percent of the portable equipment manufacturing sector is located outside of California. Given the low concentration of manufacturing in California, the negative output effects are masked by the cost-savings to the portable equipment users that face lower input costs and as a result of increasing both their capital and labor purchases. Thus, GDP (output being one major component of GDP) should follow a similar pattern to changes in output of the primary industries.

Table 16: Estimated Change in California Output Growth Relative to the BAU

		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Primary Industries															
	Change (%)	0.00%	0.00%	0.00%	-0.01%	-0.01%	-0.01%	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%	0.01%	0.02%
	Change (M$2016)	$0.0	-$0.1	-$0.1	-$0.7	-$0.5	-$0.5	-$0.4	$0.1	$0.5	$0.8	$0.9	$0.9	$1.0	$1.8
	Change (%)	0.00%	0.00%	0.00%	-0.01%	-0.01%	-0.01%	-0.01%	0.00%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%
	Change (M$2016)	-$1.5	-$1.2	-$0.9	-$19.6	-$13.9	-$16.2	-$12.0	$0.9	$10.8	$16.4	$15.0	$14.1	$12.0	$29.5
Secondary Industries															
	Change (%)	0.00%	0.00%	0.00%	0.68%	-0.38%	0.40%	-0.09%	-0.29%	0.51%	-0.39%	0.50%	-0.25%	-0.20%	-0.11%
	Change (M$2016)	$0.0	$0.0	$0.0	$16.4	-$9.4	$10.3	-$2.3	-$7.7	$13.9	-$10.9	$14.4	-$7.4	-$6.0	-$3.5

The value in each year is interpreted as the reference year value less the BAU value in that same year. The values presented above are rounded to the nearest $100,000. Percentages are rounded to the nearest hundredth.

c. Impacts on Investments in California

As modeled, the Portable Regulatory Amendments would produce very small impacts on private business investments in California, relative to the BAU scenario. There will be small changes in equipment purchases in early years, and a surge of purchases in 2020 which will slow the growth in investments in the portable equipment manufacturing sector in early years. However as the REMI model estimates, approximately 90 percent of that portable equipment sector is located outside of California, changes within state are anticipated to be small. The REMI modeling results suggest that the increase in production costs for primary industries can impact private investment, but as costs level out investments in capital stock grow slightly, relative to the BAU scenario. Table 17 shows the change in California private investments from 2017 to 2030, ranging from a 0.01 percent decrease in growth in 2020 and an increase of 0.01 percent from 2025 to 2030. The slowed growth in private investment is indiscernible from BAU given the size of California's economy which is anticipated to increase from $2.5 to $3.4 trillion from 2017 to 2030.[47]

Table 17: Estimated Change in Gross Domestic Private Investment Growth in California Relative to the BAU

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Change (%)	0.00%	0.00%	0.00%	-0.01%	0.00%	-0.01%	0.00%	0.00%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%
Change (M$2016)	-$3.0	-$2.8	-$2.3	-$35.3	-$19.0	-$22.1	-$11.6	$10.6	$29.2	$41.3	$36.6	$32.9	$32.7	$64.3

The value in each year is interpreted as the reference year value less the BAU value in that same year. The values presented above are rounded to the nearest $100,000.

d. Impacts on Individuals in California

The Portable Regulatory Amendments are estimated to produce a negligible change in personal income growth from 2017 through 2030, relative the BAU scenario. Table 18 shows that the greatest annual decline in the growth of personal income is less than 0.01 percent in 2020. The Portable Regulatory Amendments are anticipated to result in a negligible decrease in California's employment growth through 2023, with only small increases in growth beginning in 2025, as seen in Table 14. The

[47] California Department of Finance U.S. Real GDP Forecast: http://www.dof.ca.gov/Forecasting/Economics/Eco_Forecasts_Us_Ca/index.html and REMI modeling results

decreased employment results in the slowing growth of personal income. The output for personal income follows a similar pattern as employment with a one year lag, and the growth in personal income makes a slight increase after 2024 as a result of

Table 18: Estimated Change in Personal Income Growth in California Relative to the BAU

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Change (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
Change (M$2016)	-$7.4	-$3.2	-$2.6	-$97.4	-$20.9	-$60.1	-$33.4	$15.9	$42.4	$54.2	$33.5	$38.0	$43.9	$149.9

The value in each year is interpreted as the reference year value less the BAU value in that same year. The values presented above are rounded to the nearest $100,000.

decreasing production costs and corresponding increase in employment in the construction sector as seen in Table 18.

e. Impact on California Gross Domestic Product (GDP)

As presented in Table 19, the Portable Regulatory Amendments are estimated to slightly slow the growth of California GDP in the early years, relative to the BAU scenario. The impacts to California GDP, across the timeframe analyzed, follow closely with the California economic indicators described in the previous tables. The California economy will continue to grow under the Portable Regulatory Amendments with no discernable impact to GDP when compared to the BAU. The cost impacts of the Portable Regulatory Amendments will cause companies to potentially decrease employment, reduce other capital purchases, and output in their industry. Given that consumption (which will decrease slightly given the small impact to California employment) and output are drivers for GDP, a negligible impact to GDP is anticipated to follow directly with those results as Table 19 indicates. Overall, the changes in growth of GDP are indiscernible from BAU given the size of California's economy which is anticipated to increase from $2.5 to $3.4 trillion from 2017 to 2030.[48]

[48] California Department of Finance U.S. Real GDP Forecast: http://www.dof.ca.gov/Forecasting/Economics/Eco_Forecasts_Us_Ca/index.html and REMI modeling results

Table 19: Change in California's Gross State Product Growth

	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Change (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Change (M$2015)	-$2.6	-$1.8	-$0.8	-$62.7	-$58.5	-$71.9	-$72.0	-$28.9	$12.7	$11.7	$26.6	$25.1	$18.1	$101.1

The value in each year is interpreted as the reference year value less the BAU value in that same year. The values presented above are rounded to the nearest $100,000.

f. Incentives for Innovation

The Portable Regulatory Amendments are designed to encourage innovation in the manufacturing of cleaner portable engines through the gradual phase out of lower tier engines. Currently, engine manufacturers are working with portable equipment companies to design Tier 4 engines that will fit on the footprints of more types of equipment. However, more time is needed for research and development for some pieces of equipment, especially specialized equipment that is often the oldest equipment in the fleet. Delaying the compliance date affords manufacturers the time needed to manufacture more Tier 4 engines and find additional opportunities for emissions reductions, economies of scale, and efficiencies to lower the cost of Tier 4 engines.

g. Competitive Advantage or Disadvantage

Where permitting is required for California-based companies, out of state portable equipment used in California are also required to be permitted, resulting in a comparable increase in costs for both Californian and non-Californian companies. Thus, portable engine owners in California are not expected to face competitive disadvantages from engines owned by out of state operators as a result of the Portable Regulatory Amendments. The Portable Regulatory Amendments are also not anticipated to lead to business operations moving out of state because portable equipment is generally used for site specific operations.

h. Creation or Elimination of Businesses

Without the Portable Regulatory Amendments, fleets will face prohibitively high costs of compliance, and many will choose to remain out of compliance until enforced upon. Some fleets that cannot afford to come into compliance will go out of business. The Portable Regulatory Amendments were developed to provide feasible compliance pathways. As a result, there will be fewer businesses driven out of business by enforcement actions.

The Portable Regulatory Amendments result in increased costs to the primary industries in early years and decreased costs in later years. This may have a small but negative impact on total jobs and output growth in early years and will be recovered in later years (Table 14). The Portable Regulatory Amendments give entities more time to become compliant with regulations, but are unlikely to drastically change the structure of the market in ways that would incentivize firms to enter or exit the market. Thus, it is unlikely that there will be any creation or elimination of new businesses as a result of these additional costs.

The Portable Regulatory Amendments will also result in increased demand in the agriculture, construction, and mining machinery manufacturing industry. The REMI model indicates that only about 10 percent of this industry is located in California. Thus, the impact of the increase in demand faced by this industry is largely concentrated outside of California and is not likely to have a significant impact on businesses in California.

5. Summary and Agency Interpretation of the Results of the Economic Impact Assessment

The Portable Regulatory Amendments reduce compliance costs for fleets, improve ARB's ability to implement and enforce fleet emission requirements, and provides the necessary time for manufacturers to make investments towards the creation of Tier 4 engines on multiple footprints. As a result, the Portable Regulatory Amendments will lead to significantly higher compliance rates and emissions reductions when compared to the BAU. The amendments are the most cost-effective regulatory measures that are equally effective in achieving the purpose of the regulation in a manner that ensures full compliance with the authorizing statues being implemented. (See Gov. Code. § 11346.3, subd. (e).)

As modeled, the Portable Regulatory Amendments are unlikely to have significant impacts on the California economy. The estimated cost impacts of the Portable Regulatory Amendments represent a simulation of the potential effect on the directly affected industry that operates portable equipment, though actual fleet choices may vary.

E. ALTERNATIVES

In addition to the Portable Regulatory Amendments, ARB also evaluated several alternatives, as is required by the California Code of Regulations (CCR), Title 1, § 2003(e). To solicit alternatives from stakeholders, ARB presented a preliminary draft of the Portable Regulatory Amendments at the first series of public workshops on March 3, 8, and 10, 2016. Stakeholders submitted alternative proposals the following month, which ARB considered and

incorporated into the current version of the Portable Regulatory Amendments. ARB continued to solicit alternatives at subsequent workshops held in June and September and at the workgroup meetings held in April, May, June, August, and October. Stakeholders responded with input, most of which included minor variations of the current Portable Regulatory Amendments. As a result of the public process, the following are the finalized alternatives:

1. 18 Year Equipment Life with Relaxed Fleet Average Standards
2. Tiers 1-3 Phase-Out by 2025

A summary of each alternative compared to the Portable Regulatory Amendments for 2017 through 2030 is presented in Table 20, and details of each alternative are discussed in the following section. The year-by-year emissions for each alternative, the Portable Regulatory Amendments, and the BAU are presented in Figures 5 and 6.

Table 20: Statewide Direct Cost-Savings to Fleets, and Cumulative Emission Reductions for 2017 through 2030* of the Portable Regulatory Amendments and Alternatives

Scenario	Direct Cost-Savings to Fleets	Cumulative PM2.5 Emissions Reductions Relative to BAU (tpd)	Cumulative NOx Emissions Reductions Relative to BAU (tpd)
Portable Regulatory Amendments	-$232,873,201	0.58	9.7
Alternative 1	-$357,583,094	-0.12**	-6.1**
Alternative 2	-$209,063,321	0.70	11.0

*All calculations are relative to the BAU.
**Emissions are higher in Alternative 1 than the BAU.

Figure 5: Statewide PM Emissions

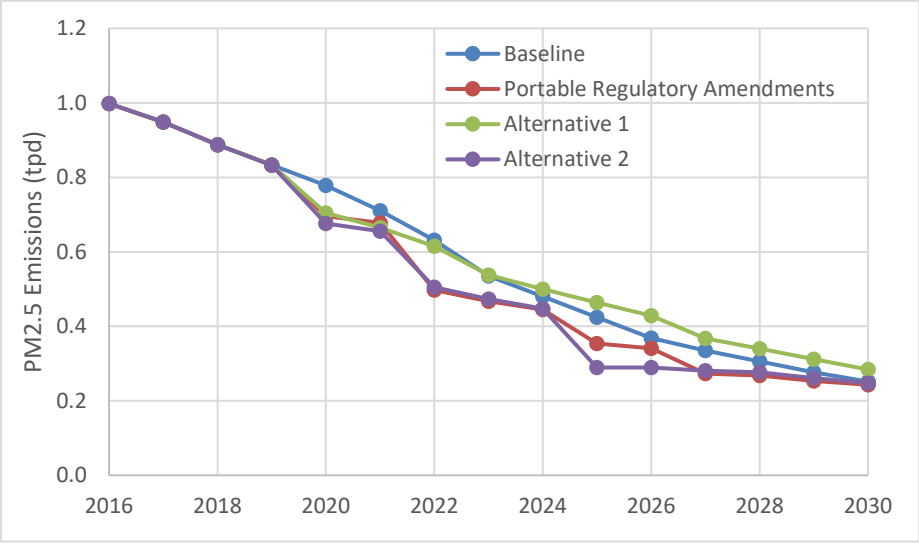
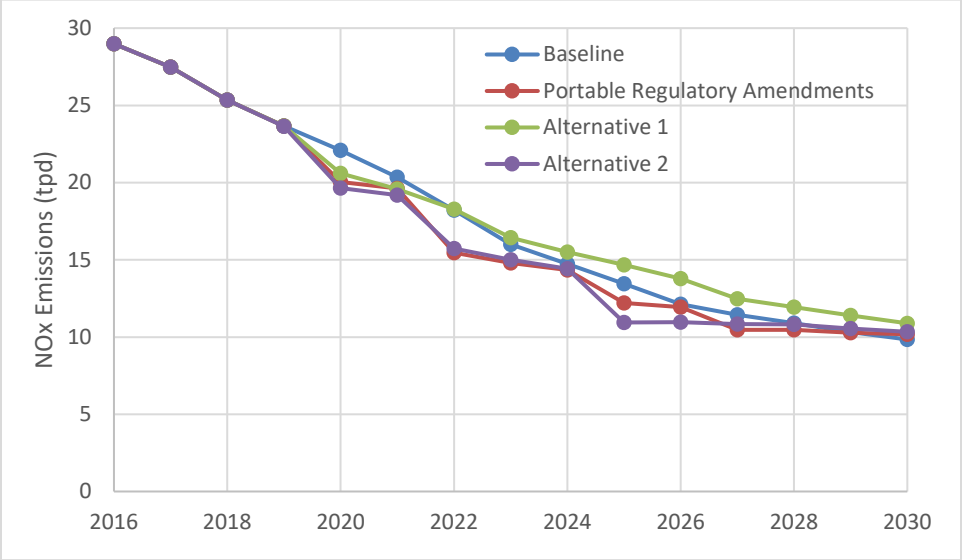


Figure 6: Statewide NOx Emissions



1. Alternative 1: 18 Year Equipment Life with Relaxed Fleet Average Standards

a. Costs and Benefits

Alternative 1 is less stringent than the Portable Regulatory Amendments because it allows older engines to operate longer. This alternative is not as costly as the Portable Regulatory Amendments for fleets, but results in a net increase in PM and NOx emissions compared to the Portable Regulatory Amendments. Thus, Alternative 1 would have reduced health benefits relative to the Portable Regulatory Amendments.

Alternative 1 would provide additional direct cost savings to the businesses choosing to follow the fleet average option compared with the Portable Regulatory Amendments. The fleet emission standards would be higher than those following the fleet averaging schedule in the Portable Regulatory Amendments with a maximum difference in 2027 where a 0.06 g/bhp-hr fleet emission standard would be required versus the proposed 0.03 g/bhp-hr fleet emission standard.

Under Alternative 1, it is assumed that an increased number of fleets would choose the fleet average option. This change would require a fleet to have an average fleet composition of 65 percent Tier 4 and 35 percent Tier 2 or 3 engines, which would result in lower total cost over the life of the rule and, consequently, a lower annual cost of compliance to the affected businesses. Based on the assumptions in the equipment turnover model, the direct cost can be estimated using methods similar to that of the Portable Regulatory Amendments outlined in the Direct Cost section. Because the fleet option for Alternative 1 is more attractive (as it is less restrictive) than the fleet option proposed in the Portable Regulatory Amendments, ARB predicts that 50 percent of the large fleets will choose the fleet average option under Alternative 1 while the rest will choose the Tier phase-out option.

Table 21 summarizes the direct costs and cost-savings for Alternative 1 and the Portable Regulatory Amendments. State spending on staff is the same between the Portable Regulatory Amendments and the Alternatives and is not reported. Table 21 shows that Alternative 1 requires less spending on equipment and DEF. Costs associated with registration or renewal fees and enforcement fees are similar between the scenarios. In total, Alternative 1 has significantly lower direct costs to fleets than the Portable Regulatory Amendments.

Table 21: Estimated Direct Costs or Cost-Savings to Fleets for 2017 through 2030 for the Portable Regulatory Amendments and Alternative 1

Scenario	Equipment	DEF Fluid	Registration or Renewal Fees	Enforcement Penalty	Net Impact
Portable Regulatory Amendments	$153,453,169	$3,511,063	$26,776,748	-$416,614,182	-$232,873,201
Alternative 1	$34,837,903	-$2,549,003	$26,742,187	-$416,614,181	-$357,583,093

Alternative 1 would achieve fewer emission reductions than the Portable Regulatory Amendments, which would result in increased health costs relative to both the Portable Regulatory Amendments and BAU. Table 22 summarizes the statewide avoided health incidence for 2017 through 2030 for the Portable Regulatory Amendments and Alternative 1. Values for Alternative 1 are negative because they represent a net increase in health incidence compared to the BAU. For example, Alternative 1 will cause 16 more premature deaths than the BAU. The Portable Regulatory Amendments, on the other hand, will reduce 38 premature deaths compared to the BAU.

Table 22: Estimated Cumulative Statewide Avoided Health Incidences from 2017 through 2030 of the Portable Regulatory Amendments and Alternative 1 Relative to the BAU*

Air Basin	Avoided Premature Mortality	Avoided Hospitalizations	Avoided ER Visits
Portable Regulatory Amendments	38 (30 - 46)	6 (1 - 13)	16 (10 - 22)
Alternative 1	-16 (-13 - -20)	-2 (-0.3 - -6)	-7 (-4 - -9)

*Values in parenthesis represent the 95 percent confidence interval

Table 23 compares the cumulative health cost for the Portable Regulatory Amendments and Alternative 1. These costs or cost-savings are not included in Table 21, because they are not direct costs to businesses. The Portable Regulatory Amendments result in $328 million in cost-savings, while Alternative 1 results in $140 million in additional costs.

Table 23: Estimated Statewide Cumulative Costs from Avoided Health Outcomes for 2017 through 2030 of the Portable Regulatory Amendments and Alternative 1 Relative to the BAU

Outcome	Cumulative Cost	
	Portable Regulatory Amendments	Alternative 1
Avoided Premature Mortality	-$327,916,887	$139,943,272
Avoided Hospitalizations	-$273,454	$117,043
Avoided ER Visits	-$11,899	$5,105

b. Economic Impacts

Compared to the BAU, Alternative 1 is estimated to have a negligible impact on California GDP, personal income, private investment, and other economic indicators as shown in Table 24. In addition to costs discussed above, Alternative 1 would also result in health dis-benefits, and less cost-savings, which is accounted for in the REMI analysis. The macroeconomic modeling results for Alternative 1 are not significantly different than the Portable Regulatory Amendments in percentage terms. In absolute terms, Alternative 1 exhibits smaller decreases in the various economic indicators between 2020 and 2024 and slightly higher values for growth from 2025 to 2030.

c. Cost-Effectiveness

Cost-effectiveness is defined as the cost to achieve a ton of emissions reduction. In the case of Alternative 1, the total cost-savings for businesses is small relative to the increased overall emissions though 2030. Thus, Alternative 1 is a less cost-effective alternative compared to the Portable Regulatory Amendments.

d. Reason for Rejection

Alternative 1 was rejected because the Portable Regulatory Amendments will achieve greater emission reductions while remaining economically feasible. The lower cost to businesses offered by Alternative 1 comes with high statewide emission rates which would adversely affect public health and is not the intent of the PERP and ATCM.

Table 24: Estimated Change in Economic Indicators for Alternative 1 Relative to the BAU

		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	Change (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change (M$2016)	-2.6	-1.7	-0.7	-50.4	-42.7	-16.0	-12.8	22.9	106.6	89.2	70.1	54.1	35.4	43.8
	Change (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change (M$2016)	-7.4	-3.1	-2.6	-78.7	-4.8	17.1	23.1	66.2	161.1	119.5	76.7	54.9	63.1	73.0
	Change (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change in Jobs	-25	-0	0	-475	-400	-200	-200	125	800	600	425	300	100	125
	Change (%)	0.00%	0.00%	0.00%	-0.01%	0.00%	0.00%	0.00%	0.01%	0.02%	0.02%	0.01%	0.01%	0.01%	0.01%
	Change (M$2016)	-3.0	-2.7	-2.3	-28.8	-10.7	7.1	18.7	37.5	75.3	76.7	58.3	38.7	32.1	31.7

The value in each year is interpreted as the reference year value less the BAU value in that same year. The change in jobs is rounded to the nearest 25, while the dollar values are rounded to the nearest $100,000.

2. Alternative 2: Tiers 1-3 Phased-out by 2025

In Alternative 2 the final compliance date is two years earlier for large fleets and four years earlier for small fleets than in the Portable Regulatory Amendments. Alternative 2 has a compressed timeframe for compliance and results in higher compliance costs in those years. The Portable Regulatory Amendments phase-out **most** Tier 1-3 engines by 2025 while Alternative 2 would phase out **all** Tier 1-3 engines by 2025. Phasing out all Tier 3 engines and Tier 2 engines greater than 750 horsepower in 2025 would impose high equipment replacement costs in 2025 comparable to costs projected for compliance with the existing ATCM's 2017 fleet standards ARB has suspended. It is unclear if widespread compliance is possible under Alternative 2. This uncertainty could result in higher emission rates and higher costs due to enforcement fines than projected.

Alternative 2 would utilize the same fleet standards as the Portable Regulatory Amendments, but would require these fleet standards to be met earlier as shown in Table 25 below. This alternative would also use a different Tier Phase-out schedule, as shown in Table 26 below. This option achieves earlier emission reductions, while the Portable Regulatory Amendments will achieve the same emissions levels as Alternative 2 in 2029, though at a lower cost to industry.

Table 25: Alternative 2 Fleet Average Option for Large Fleets

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

Table 26: Alternative 2 Tier Phase-Out Schedule

	Engines rated 50 to 750 bhp		
	Large Fleet	***Small Fleet***	
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
Flex engines (Tier 1,2, and 3)	Treated as the Tier the engine was built to.		

a. Costs and Benefits

Assuming fleets can comply, Alternative 2 would result in lower levels of PM and NOx emissions relative to the Portable Regulatory Amendments which would provide additional health benefits.

Table 27 summarizes the direct costs and cost-savings for Alternative 2 and the Portable Regulatory Amendments. State spending on staff is the same between the Portable Regulatory Amendments and the Alternatives and is not reported. The table shows that Alternative 2 requires increased spending on equipment and DEF compared to the Portable Regulatory Amendments. Costs associated with registration or renewal fees and enforcement fees are similar between the scenarios. In total, Alternative 2 results in slightly lower cost-savings to fleets than the Portable Regulatory Amendments.

Table 27: Estimated Direct Costs or Cost Savings to Fleets for 2017 through 2030 of the Portable Regulatory Amendments and Alternative 2

Scenario	Equipment	DEF Fluid	Registration or Renewal Fees	Enforcement Penalty	Net Impact
Portable Regulatory Amendments	$153,453,169	$3,511,063	$26,776,748	-$416,614,182	-$232,873,201
Alternative 2	$173,992,783	$6,753,725	$26,804,352	-$416,614,181	-$209,063,320

Alternative 2 would achieve more emission reductions than the Portable Regulatory Amendments, which would result in increased health benefits and heath cost savings compared to the Portable Regulatory Amendments. Table 28 summarizes the statewide avoided health incidence for 2017 through 2030 for the Portable Regulatory Amendments and Alternative 2.

Table 28: Estimated Cumulative Statewide Avoided Health Incidences from 2017 through 2030 of the Portable Regulatory Amendments and Alternative 2 relative to the BAU*

Air Basin	Avoided Premature Mortality	Avoided Hospitalizations	Avoided ER Visits
Portable Regulatory Amendments	38 (30 - 46)	6 (1 - 13)	16 (10 - 22)
Alternative 2	44 (35 - 54)	7 (1 - 15)	19 (12 - 26)

*Values in parenthesis represent the 95 percent confidence interval

Table 29 compares the cumulative health cost for the Portable Regulatory Amendments and Alternative 2. The Portable Regulatory Amendments result in an estimated $328 million in cost-savings, while Alternative 2 results in an estimated $384 million in cost-savings from 2017 through 2030.

Table 29: Estimated Statewide Cumulative Costs from Avoided Health Outcomes for 2017 through 2030 of the Portable Regulatory Amendments and Alternative 2 Relative to the BAU

Outcome	Cumulative Cost	
	Portable Regulatory Amendments	Alternative 2
Avoided Premature Mortality	-$327,916,887	-$383,912,265
Avoided Hospitalizations	-$273,454	-$320,104
Avoided ER Visits	-$11,899	-$13,928

b. Economic Impacts

Alternative 2 results in increased costs to fleets, and additional cost-savings for health benefits. Table 30 compares the macroeconomic modeling results for Alternative 2 compared to the BAU. Estimated changes in California GDP, personal income, and employment are very similar to the economic impacts of the Portable Regulatory Amendments. While this alternative is more costly and the growth of GDP, employment, investment and personal income are all lower than the Portable Regulatory Amendments, these changes are very small compared to the size of the California economy.

c. Cost-Effectiveness

Alternative 2 would result in a higher compliance costs but would also result in slightly lower statewide emissions than the Portable Regulatory Amendments. However, the differences between the two scenarios are not large. The cost-effectiveness of Alternative 2 is similar to the cost-effectiveness of the Portable Regulatory Amendments.

d. Reason for Rejection

Assuming full compliance, Alternative 2 achieves greater emissions reductions and a greater overall economic benefit than the Portable Regulatory Amendments but creates unreasonable compliance costs in 2025. Under this alternative, ARB estimates fleets would incur $484 million in non-amortized equipment replacement costs in 2025 (the final compliance year) which is greater than the $459 million non-amortized equipment replacement costs fleets would incur to fully comply with the 2017 standards in the current ATCM. This high cost could reasonably be expected to be economically unfeasible for fleets driving them to operate out of compliance. Compliance rate uncertainty with the 2025 standards could result in higher emission rates than projected and enforcement fines to fleets. Since many of the engines requiring replacement in 2025 are certified under flexibility provisions of the standard and were purchased after 2009, fleets would need to replace equipment much more quickly than originally envisioned. Given the high cost of equipment, age of equipment being replaced, and the number of engines requiring replacement in 2025, it is necessary to spread compliance costs over several years in order to allow fleets to be able to make the necessary investments to meet regulatory requirements. The Portable Regulatory Amendments spread these costs over several years, Alternative 2 does not.

Table 30: Estimated Change in Economic Indicators for Alternative 2 Relative to the BAU

		2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
	Change (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change (M$2016)	-2.6	-1.8	-0.8	-68.1	-66.2	-90.6	-75.6	-28.9	-62.5	-90.8	14.4	20.9	22.3	198.0
	Change (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
	Change (M$2016)	-7.4	-3.2	-2.6	-105.6	-29.2	-84.8	-27.8	15.3	-72.2	-55.0	62.4	35.3	48.3	271.1
	Change (%)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.01%
	Change in Jobs	-25	-25	-0	-650	-625	-875	-725	-300	-625	-850	50	100	75	1425
	Change (%)	0.00%	0.00%	0.00%	-0.01%	-0.01%	-0.01%	0.00%	0.00%	0.00%	0.00%	0.01%	0.01%	0.01%	0.02%
	Change (M$2016)	-$3.0	-$2.8	-$2.3	-$38.3	-$23.1	-$32.1	-$13.4	$10.6	-$7.2	-$8.6	$27.3	$33.8	$40.0	$109.8

The value in each year is interpreted as the reference year value less the BAU value in that same year. The change in jobs is rounded to the nearest 25, while the dollar values are rounded to the nearest $100,000.

F. FISCAL IMPACTS

1. Local government

Local government agencies have two separate roles under the Portable Regulatory Amendments. Many local government agencies register their portable equipment units in PERP and will see higher equipment costs, DEF costs, and registration fees under the Portable Regulatory Amendments compared to the BAU. They will also see cost savings in the form of reduced penalties for non-compliance. In the second role, the 35 California air districts regulate portable equipment and enforce the PERP registrations. A portion of the higher registration fees in the Portable Regulatory Amendments will be distributed to the local air districts representing increased revenue to local government.

Local governments comprise about 4.8 percent of total portable equipment (by horsepower). The Portable Regulatory Amendments result in increased equipment costs, increased DEF costs, increased registration costs, and decreased enforcement penalties. The estimated impact to local fleets was assumed to be 4.8 percent of total direct costs discussed in Section C. Thus cumulative cost savings to local government agencies between 2017 and 2030 is approximately $11,177,913, or 4.8 percent of cumulative direct cost-savings in Section C.

Increased registration fees (for all fleets including those owned by local agencies) will provide increased revenue to local air districts. Currently, the district portion of the fee is $345 for both a renewal and an initial registration. Under the Portable Regulatory Amendments the fee would increase to $405, a $60 increase per engine. In total, the air districts are expected to see an increase in revenue of approximately $9,578,578 between 2017 and 2030, or $684,184 per year on average. The amount allotted to each district will vary depending upon the number of renewals or new registrations annually in each district. As indicated in the Direct Cost Section (Section C) to find the total increase in fees in each year, the difference between the renewals or newly registered engines in any given year for the Portable Regulatory Amendments and the BAU is obtained (see Table 11), then these values are multiplied by their corresponding increase in fees. The districts will receive $60 of the increase for each new renewal and newly registered engine and the remaining funds are distributed to ARB. This increase in revenue is expected to cover any additional staffing or training needs at local air districts.

With the reduction in PM and NOx emissions and improvement in overall air quality, it is expected that local governments will benefit from fewer employee sick days and a reduction in public hospital and ER visits. The Portable Regulatory Amendments will lead to health-related cost savings tabulated in Section B, but the share of cost savings attributable to local government are not easily quantified. Based on the spatial distribution of emission reductions and associated health benefits (Table 6), most cost-savings will occur in the South Coast and San Francisco Bay. Local governments will also benefit from a greater ability to attain regional air quality goals.

2. State Government

State government comprises about 1 percent of the total registered horsepower in PERP and as a result, State fleets are anticipated to obtain 1 percent of direct cost-savings described in

Section C. Thus cumulative cost-savings to State government agencies between 2017 and 2030 is approximately $2,328,732. Increased revenue from permit fees will go to ARB, and is discussed in the next section.

State government will likely generate additional cost-savings through reduced hospital visits at state run hospitals and reduced sick days for state employees. The projected changes in hospital visits will also affect general fund costs through changes in state Medi-Cal expenditures. Medi-Cal, California's version of Medicaid, provides health coverage for children and adults with limited resources and is funded both by federal and state funds. A potential method to estimate the changes in general fund costs is multiplying the change in hospital expenditures by the Medi-Cal's share of California's hospital care expenditures and by the state's share of Medi-Cal spending. Specifically,

$$\Delta General\ Fund\ Costs = \Delta Hosptial\ Expenditures \times \left(\frac{M}{C}\right) \times S$$

where M is the value of Medi-Cal hospital care spending in California (including both State and federal funds), C is the total value of hospital care expenditures in California, and S is the state share of Medi-Cal spending. This approach assumes that hospitalizations and ER visits due to respiratory conditions and asthma will fall under the expenditure classification of hospital care as categorized by the Centers for Medicare and Medicaid Services. In addition, this methodology assumes that individuals utilizing hospital care due to asthma or respiratory conditions are no more or no less likely to be insured through Medi-Cal than individuals in the general population. Finally, the methodology assumes that the state share of Medi-Cal spending on hospital care is the same as the share of state spending on Medi-Cal as a whole. There is insufficient information about the distribution of health impacts and year to year budget details to further refine these assumptions.

Data on hospital care spending in California is available from the Centers for Medicare and Medicaid Services, Office of the Actuary, National Health Statistics Group. From 2010 through 2014 (the most recent year with reported data), the ratio of Medi-Cal expenditures on hospital care to total expenditures on hospital care has increased from 19.6 to 23.1 percent, an average annual growth rate of 4.8 percent.[49] Extrapolating this out to 2016 would imply a ratio of 25.4 percent.

In 2014, the state share of Medi-Cal expenditures was 43.6 percent.[50] This percentage has increased in the past few years, in part due to the Affordable Care Act (ACA) optional expansion and the federal medical assistance percentages assigned to the ACA optional expansion population.[51] In 2016, the state share of Medi-Cal expenditures was 35.9 percent.[52]

[49] Centers for Medicare & Medicaid Services (2017). *Health Expenditures by State of Provider*. Retrieved (7/11/2017) at https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/NationalHealthAccountsStateHealthAccountsProvider.html

[50] Medicaid Expenditure Reports: https://www.medicaid.gov/medicaid/financing-and-reimbursement/state-expenditure-reporting/expenditure-reports/index.html

[51] Medical's budget: http://www.lao.ca.gov/Publications/Report/3612#Governor.2019s_Budget_Caseload_Projections

[52] Federal and State Share of Medicaid Spending | The Henry J. Kaiser Family Foundation. http://www.kff.org/medicaid/state-indicator/federalstate-share-of-spending/?currentTimeframe=0&selectedRows=%7B%22states%22:%7B%22california%22:%7B%7D%7D%7D&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D#notes

This share may increase over the next several years as the federal medical assistance percentages assigned to the ACA optional expansion population declines.
Using the values of the state share of Medi-Cal expenditures from 2014 to 2016, and the observed and forecasted ratio of Medi-Cal expenditures to total expenditures on hospital care, the data suggests that 8.2 to 11.6 percent of the cost savings for hospital care from the proposed amendments would go to the state General Fund. The magnitude of cost savings from the proposed amendments, however, is small compared to total State spending on medical care.

As outlined in the Section C, the increase in registration costs will increase the revenue to support the PERP by $185 for each new registration and $165 for a renewal of each registration (see Table 10). ARB is expected to retain approximately $1.2 million per year on average between 2017 and 2030, after accounting for fees to local government. This is calculated by multiplying the annual new registration numbers (presented in Table 11) by $185, and the registration renewals (also presented in Table 11) by $165, summing these numbers and subtracting the portion of registration fees, $60, apportioned to local government.

PERP was established as a self-funded program. However, in recent years, it became apparent that the program is both understaffed and underfunded. The proposed fee increases are intended to support the additional staff necessary to properly implement and enforce the Portable Regulatory Amendments. ARB anticipates the need for $1,064,000 in the first year, and $1,054,000 in ongoing years to cover ten new staff positions: 1.0 Air Resources Supervisor I, 1.0 Software Systems Specialist III, 1.0 Senior Accounting Officer, and 1.0 Staff Services Analyst. In addition, 9.0 existing intermittent Air Resources Technician positions would be converted to 6.0 full-time positions to support the program. These costs were included in macroeconomic modeling scenarios (Section D). It is estimated that the currently proposed program fee increase would be sufficient to fund these positions.

ATTACHMENT - HEALTH MODELING METHODOLOGY

To estimate the change in health outcomes from changes in emissions due to the proposed amendments, ARB uses the incidents-per-ton (IPT) methodology.[53] This methodology quantifies the health benefits of primary and secondary PM2.5 reductions due to regulatory controls. Primary PM2.5 is emitted directly from the source, for example, the black particles in diesel exhaust. Secondary PM2.5 is formed in the atmosphere as a result of chemical reactions. NOx emissions are converted by atmospheric processes to secondary ammonium nitrate PM2.5. Therefore, NOx emission reductions from the proposed amendments will result in a reduction in PM2.5 exposure.

This methodology is similar to the methodology developed by the U.S. EPA for health benefit estimations,[54] but uses California air basin specific relationships between emissions and air quality. The basis of the IPT methodology is the approximately linear relationship which holds between changes in emissions and estimated changes in health outcomes. Therefore, health outcomes are approximately proportional to emissions, and changes in health outcomes from the proposed amendments can be estimated by multiplying changes in emissions by a reference incidence factor, known as the IPT factor.
IPT factors were derived for a reference scenario by identifying the health incidence associated with a PM2.5 source in an air basin, and dividing by the emissions of that PM2.5 source, as in the following equation. This reference scenario is based on 2009 through 2011 average data used in IPT factor development, and is not the same as the regulatory BAU. Separate IPT factors were developed for each health endpoint, air basin, and for primary PM2.5 and NOx emissions.

$$IPT\ Factor = \frac{Reference\ Incidence\ (\#\ cases)}{Reference\ Emissions\ (tons)}$$

A change in health outcomes from the proposed amendments can then be calculated by multiplying the emission change in a given year by the IPT Factor. Since the total incidence of health outcomes is also proportional to population, the change in health outcomes are additionally scaled by the ratio of the population in a given year to the population in the reference year, which is the 2009 through 2011 average. The equation used to estimate health outcomes is:

$$Health\ Outcome_Y = [Emission\ Change_Y(tons)] * \left[IPT\ Factor\ (\frac{incidents}{ton})\right] * \left[\frac{Population_Y}{Population_R}\right]$$

where Y is a given year for which the proposed amendments lead to a change in PM2.5 emissions, and R is the reference case. The change in health outcomes is calculated for each health endpoint, air basin, year, and for both primary PM2.5 and NOx emissions. A further description of the methodology, assumptions, and uncertainty follows.

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[53] Initial Statement of Reasons, Appendix J – Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use Heavy-Duty Diesel-Fueled Vehicles. Air Resources Board, 2010. https://www.arb.ca.gov/regact/2010/truckbus10/correctedappj.pdf

[54] Neal Fann, Kirk R. Baker, Charles M. Fulcher, Characterizing the PM-related health benefits of emission reductions for 17 industrial, area and mobile emission sectors across the U.S., Environment International, Volume 49, 2012, Pages 141-151, ISSN 0160-4120, http://dx.doi.org/10.1016/j.envint.2012.08.017.

IPT Factors

A detailed description of the methodology used to calculate premature mortality from PM2.5 has been published, and is similar to that used to determine IPT factors.[55] IPT factors for other health endpoints are calculated using similar methodology. Calculating IPT factors requires reference incidence rates, population data, ambient concentrations of PM2.5, and a concentration-response function (CRF) relating changes in PM2.5 exposure to changes in health incidence.[56] The underlying analysis was performed at the census tract level, then aggregated to air basin and statewide results.

Reference incidence rates are the number of cases of death or illness in the exposed population. Incidence rates vary according to age; for instance, an older person is more likely to die or be hospitalized because of heart disease or stroke than a child or young adult. Age-specific incidence rates were taken from the Centers for Disease Control and Prevention Wonder database.[57] The ARB methodology divides the population into five-year age brackets up to ages 80-84, and an 85+ age bracket. Thus this analysis reflects differences in vulnerability between different age groups.

Population exposure to PM2.5 was estimated from monitored or modeled concentrations of PM2.5. Consistent with U.S. EPA practice, ARB uses the software program BenMap, which uses input exposure data and CRF to calculate estimated mortality.
Following recent U.S. EPA practice, CRF for death from heart disease and stroke are taken from a study by Krewski et al.,[58] for hospital admissions for heart and lung disease from a study by Bell et al.,[59] and for asthma emergency room visits from a study by Ito et al.[60] Change in cardiopulmonary mortality were not quantified when the concentration were below 5.8 $\mu g/m^3$, because the Krewski et al. study did not examine impacts below that concentration. The IPT factors were originally developed for use with on-road diesel PM emissions, but are also applied to PM from portable diesel equipment. This assumes that the emission patterns for PM from portable diesel equipment are similar to those for PM from on-road diesel vehicles. That is, a ton of PM2.5 emitted from portable equipment is expected to result in the same PM2.5 exposure and health effects as a ton of PM2.5 emitted from on-road diesel vehicles.

[55] Estimate of Premature Deaths Associated with Fine Particle Pollution (PM2.5) in California Using a U.S. Environmental Protection Agency Methodology. Air Resources Board, 2010. https://www.arb.ca.gov/research/health/pm-mort/pm-report_2010.pdf

[56] Initial Statement of Reasons, Appendix J – Methodology for estimating Ambient Concentrations of Particulate Matter from Diesel-Fueled Engine Emissions and Health Benefits Associated with Reductions in Diesel PM Emissions from In-Use On-Road Heavy-Duty Diesel-Fueled Vehicles. Air Resources Board, 2010. https://www.arb.ca.gov/regact/2010/truckbus10/correctedappj.pdf

[57] Centers for Disease Control and Prevention. Wonder Online Database. https://wonder.cdc.gov/

[58] Krewski et al. (2009) Extended Follow-Up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality. Health Effects Institute Research Report 140. https://ephtracking.cdc.gov/docs/RR140-Krewski.pdf.

[59] Bell et al. (2008) Seasonal and Regional Short-term Effects of Fine Particles on Hospital Admissions in 202 US Counties, 1999–2005. American Journal of Epidemiology. 168(11): 1301–1310. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2732959/.

[60] Ito et al. (2007) Characterization of PM2.5, gaseous pollutants, and meteorological interactions in the context of time-series health effects models. Journal of Exposure Science and Environmental Epidemiology. Vol. 17: S45-60. https://www.nature.com/jes/journal/v17/n2s/pdf/7500627a.pdf

Population Scaling

Population was estimated by taking 2010 Census data for total population by age bracket and projecting to 2026 using total county population projections from the California Department of Finance (DOF). This accounts for overall population growth in a county but does not reflect shifts in the spatial distribution of the population such as new housing developments built on previously undeveloped land.

The original population estimation analysis was performed in 2014. Though this is not the most recent data available from DOF, the population discrepancy between the data used in this analysis and the July 2017 DOF forecast[61] is less than two percent in a given year, and is randomly distributed among years (i.e., sometimes higher and sometimes lower). This uncertainty is much lower than the uncertainty for estimating either emissions changes or health outcomes, so does not meaningfully contribute to error in this analysis.

Uncertainty

This health benefit analysis relies on multiple data sources and assumptions that contain significant inherent uncertainty. The reference case used to develop IPT factors reconstructs ambient concentrations of both primary PM2.5 and secondary ammonium nitrate formed in the atmosphere from NOx emissions to estimate population exposure. These datasets were constructed from California's ambient monitoring networks, which have limited spatial and temporal coverage. Atmospheric concentrations of PM vary dramatically both spatially and temporally depending on the emission behavior of local sources, the local meteorological conditions, and topographical features. Extrapolating atmospheric concentrations between air quality monitors adds uncertainty to the underlying methodology.

CRF functions are also used to develop IPT factors, and are based on the best available scientific literature, but are difficult to measure and contain inherent uncertainty. These CRF functions do not have sufficient detail to account for all sensitive populations, specifically populations with low socioeconomic status.

Another important source of uncertainty is projected emission inventories under the baseline and proposed amendments. Projecting emission inventories relies on ARB expert judgment of likely future equipment technology changes and business behavior both in the absence of (i.e., baseline) and presence of the proposed amendments. ARB worked closely with stakeholders to identify the likely response from business both with and without the proposed amendments. Still, unforeseen events could occur that dramatically change future emissions. In addition, the spatial distribution of future emission reductions as a result of the proposed amendments contributes high uncertainty. Health outcomes at the air basin level are presented in this analysis, but represent higher uncertainty than the statewide analysis. It is not possible to accurately constrain the error in projected emission inventories due to lack of information about future conditions.

[61] California Department of Finance, 2017. P-1: State Population Projections (2010-2060) – Total Population by County. http://www.dof.ca.gov/Forecasting/Demographics/Projections/

Some of the uncertainty described above is accounted for in the health outcome calculation, as represented by the 95 percent confidence intervals. Importantly, error associated with projected emission inventories is not included in these confidence intervals. The error associated with the projected emission inventories could contribute significant additional error.

REFERENCES

1. 40 CFR 89, 1039 Control of Emissions of Air Pollution from Nonroad Diesel Engines and Fuel; Final Rule. https://www.gpo.gov/fdsys/pkg/FR-2004-06-29/pdf/04-11293.pdf June 2004
2. Advisory 347. Portal Diesel Engine Airborne Toxic Control Measure. California Air Resources Board. https://www.arb.ca.gov/enf/advs/advs347.pdf December 2015.
3. Off-Road Diesel Vehicle Regulation and Verified Diesel Emissions Control Strategies (VDECS). https://www.arb.ca.gov/msprog/ordiesel/vdecs.htm June 2014.
4. 40 CFR 1039.625 – "What Requirements Apply Under the Program for Equipment Manufacturer Flexibility." https://www.gpo.gov/fdsys/granule/CFR-2014-title40-vol33/CFR-2014-title40-vol33-sec1039-625 July 2014.
5. Initial Statement of Reasons for Proposed Rulemaking. Airborne Toxic Control Measure for Diesel-Fueled Portable Engines. California Air Resources Board. https://www.arb.ca.gov/regact/porteng/isor.pdf January 2004.
6. Statewide Portable Equipment Registration Program – Regulatory Activity. California Air Resources Board. https://www.arb.ca.gov/portable/perpact/portable-activity.htm June 2017
7. List Serve – Portable Equipment Registration Program. https://www.arb.ca.gov/listserv/listserv_ind.php?listname=portable August 2017.
8. U.S. EPA. Quantitative Health Risk Assessment for Particulate Matter. https://www.epa.gov/ttn/naaqs/standards/pm/data/PM_RA_FINAL_June_2010.pdf June 2010.
9. Integrated Science Assessment for Particulate Matter. U.S. EPA. EPA/600/R-08/139F. http://ofmpub.epa.gov/eims/eimscomm.getfile?p_download_id=494959 December 2009.
10. Estimate of Premature Deaths Associated with Fine Particle Pollution (PM2.5) in California Using a U.S. Environmental Protection Agency Methodology. California Air Resources Board. https://www.arb.ca.gov/research/health/pm-mort/pm-report_2010.pdf August 2010.
11. Krewski et al. Extended Follow-Up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality. Health Effects Institute Research Report 140. https://ephtracking.cdc.gov/docs/RR140-Krewski.pdf 2009.
12. Gwynn, R.C., Thurston, G.D. The Burden of Air Pollution: Impacts Among Racial Minorities. Environmental Health Perspectives; Volume 109, Supplement 4: 501–6. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC1240572/ August 2001.
13. "Appendix B: Mortality Risk Valuation Estimates, Guidelines for Preparing Economic Analyses." EPA 240-R-10-001. U.S. EPA. http://yosemite.epa.gov/ee/epa/eerm.nsf/vwAN/EE-0568-22.pdf/$file/EE-0568-22.pdf December 2010.

14. "A SAB Report on EPA's White Paper *Valuing the Benefits of Fatal Cancer Risk Reduction*." EPA-SAB-EEAC-00-013. U.S. EPA Science Advisory Board. http://yosemite.epa.gov/sab%5CSABPRODUCT.NSF/41334524148BCCD6852571A700516498/$File/eeacf013.pdf July 2000.
15. Mortality Risk Valuation – "What does it mean the place a value on a life?" U.S. EPA. https://www.epa.gov/environmental-economics/mortality-risk-valuation#means Accessed July 2017.
16. Chestnut, L. G., Thayer, M. A., Lazo, J. K., and Van Den Eeden, S.K. "The Economic Value of Preventing Respiratory and Cardiovascular Hospitalizations." Contemporary Economic Policy, 24: 127–143. http://onlinelibrary.wiley.com/doi/10.1093/cep/byj007/full January 2006.
17. Lee, K.H. et al. Occupational Exposure to Diesel Particulate Matter in Municipal Household Waste Workers. https://doi.org/10.1371/journal.pone.0135229 August 2015
18. "Valuing Mortality Risk Reductions for Environmental Policy: A White Paper." U.S. EPA. https://yosemite.epa.gov/ee/epa/eerm.nsf/vwan/ee-0563-1.pdf/$file/ee-0563-1.pdf December 2010.
19. Cummins Tier 4 Technology Overview. https://www.cdc.gov/niosh/mining/UserFiles/workshops/dieselaerosols2012/NIOSHMVS2012Tier4TechnologyReview.pdf Accessed August 2017.
20. Diesel Exhaust Fluid – 55 Gallon Drum. https://www.google.com/search?q=def+55+gallon+drum&ie=utf-8&oe=utf-8#q=def+55+gallon+drum&tbm=shop Accessed August 2017.
21. "Chapter 1 – Standardized Regulatory Impact Assessment for Major Regulations." Gov. Code, §§ 11346.3, 11346.36; 1 Cal. Code Regs., tit. 1 §§ 2000-2004. Division 3 – Department of Finance. http://dof.ca.gov/Forecasting/Economics/Major_Regulations/SB_617_Rulemaking_Documents/documents/Order_of_Adoption-1.pdf Accessed August 2017.
22. California Department of Finance U.S. Real GDP Forecast. http://www.dof.ca.gov/Forecasting/Economics/Eco_Forecasts_Us_Ca/index.html April 2017.
23. Centers for Medicare & Medicaid Services. *Health Expenditures by State of Provider*. https://www.cms.gov/Research-Statistics-Data-and-Systems/Statistics-Trends-and-Reports/NationalHealthExpendData/NationalHealthAccountsStateHealthAccountsProvider.html Accessed July 2017.
24. Medicaid - Expenditure Reports from MBES/CBES. https://www.medicaid.gov/medicaid/financing-and-reimbursement/state-expenditure-reporting/expenditure-reports/index.html Accessed August 2017.
25. Legislative Analyst's Office. "Analysis of the Medi-Cal Budget - Governor's Budget Caseload Projections." http://www.lao.ca.gov/Publications/Report/3612#Governor.2019s_Budget_Caseload_Projections March 2017.

26. The Henry J. Kaiser Family Foundation. Federal and State Share of Medicaid Spending http://www.kff.org/medicaid/state-indicator/federalstate-share-of-spending/?currentTimeframe=0&selectedRows=%7B%22states%22:%7B%22california%22:%7B%7D%7D%7D&sortModel=%7B%22colId%22:%22Location%22,%22sort%22:%22asc%22%7D#notes Accessed August 2017.
27. Initial Statement of Reasons - Appendix J "Regulation to Reduce Emissions of Diesel Particulate Matter, Oxides of Nitrogen and Other Criteria Pollutants from In-Use Heavy-Duty Diesel-Fueled Vehicles." California Air Resources Board. https://www.arb.ca.gov/regact/2010/truckbus10/correctedappj.pdf 2010.
28. Fann, N., Baker, K., Fulcher, C. "Characterizing the PM2.5 related health benefits of emission reductions for 17 industrial, area and mobile emission sectors across the U.S." Environment International, Volume 49: 141-151 http://dx.doi.org/10.1016/j.envint.2012.08.017. November 2012.
29. Estimate of Premature Deaths Associated with Fine Particle Pollution (PM2.5) in California Using a U.S. Environmental Protection Agency Methodology. California Air Resources Board. https://www.arb.ca.gov/research/health/pm-mort/pm-report_2010.pdf August 2010.
30. Centers for Disease Control and Prevention. Wonder Online Database. https://wonder.cdc.gov/ Accessed 2017.
31. Krewski et al. Extended Follow-Up and Spatial Analysis of the American Cancer Society Study Linking Particulate Air Pollution and Mortality. Health Effects Institute Research Report 140. https://ephtracking.cdc.gov/docs/RR140-Krewski.pdf 2009.
32. Bell et al. Seasonal and Regional Short-term Effects of Fine Particles on Hospital Admissions in 202 US Counties, 1999–2005. American Journal of Epidemiology. Vol. 168, No.11: 1301–1310. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2732959/ October 2008.
33. Ito et al. Characterization of PM2.5, gaseous pollutants, and meteorological interactions in the context of time-series health effects models. Journal of Exposure Science and Environmental Epidemiology. Vol. 17, S45-60. https://www.nature.com/jes/journal/v17/n2s/pdf/7500627a.pdf September 2007.
34. California Department of Finance. P-1: State Population Projections (2010-2060) – Total Population by County. http://www.dof.ca.gov/Forecasting/Demographics/Projections/ Accessed 2017.