South Coast AQMD

APPENDIX III

Stationary and Mobile Source BACM/MSM

Table of Contents

Introduction

The South Coast Air Basin (Basin) was reclassified from "moderate" to "serious" nonattainment for the 2012 annual PM2.5 National Ambient Air Quality Standard (NAAQS or standard) of 12 µg/m^3 effective December 9, 2020, with an attainment date of December 31, 2025.[1] Subpart 4 of the federal Clean Air Act (CAA) Part D specifies additional provisions for PM2.5 nonattainment areas. In particular, CAA Section 189(b) requires states to submit an attainment plan that meets "serious" area plan requirements and address attainment strategies for the 2012 annual PM2.5 standard.

Under CAA Section 189(b)(1)(B), a "serious" nonattainment area must demonstrate provisions to ensure that Best Available Control Measures (BACM), which includes Best Available Control Technology (BACT), for the control of PM from stationary sources are implemented no later than four years after the designation (or reclassification). In the Addendum to the General Preamble for the Implementation of Title I of the Clean Air Act Amendments of 1990 issued by U.S. EPA in 1994 (1994 Addendum),[2] BACM is defined as:

> "The maximum degree of emissions reduction achievable from a source or source category which is determined on a case-by-case basis, considering energy, economic and environmental impacts and other costs."

Similarly, BACT is defined as:

> "An emission limitation which is based on the maximum degree of control that can be achieved. It is a case-by-case decision that considers energy, environmental and economic impact."

The implementation of BACT is required for major stationary sources (i.e., sources that emit PM2.5 or any PM2.5 precursor in an amount exceeding 70 tons per year). BACT can be add-on control equipment or modification of the production processes or methods, including fuel cleaning or treatment and innovative fuel combustion techniques. In addition, BACT may be a design, equipment, work practice, or operational standard if imposition of an emissions standard is infeasible.

In addition to BACM and BACT, PM2.5 attainment plans must also include additional feasible measures that either assist with attainment or advance the attainment date by one year. Additional feasible measures may be implemented later than BACM/BACT but before the statutory "serious" area attainment date.

The control measure assessment for this plan seeks to evaluate the technological and economic feasibility of potential BACM and to identify additional feasible measures. The demonstration generally involves an analysis of South Coast AQMD's control requirements as they compare to those in other jurisdictions. Other sources such as U.S. EPA guidance documents are also consulted. When South Coast AQMD's

[1] 85 FR 71264
[2] 59 FR 41998, 42010

control requirements meet the BACM/BACT definition, no further analysis is required. When a regulation or control measure from another air basin or from U.S. EPA guidance is identified as more stringent than South Coast AQMD's regulation, the measure is analyzed for technological and economic feasibility. While South Coast AQMD is not required to adopt a measure just because it was adopted in another region, the rationale for rejecting such measures must be presented.

In addition to implementing BACM/BACT and additional feasible measures, "serious" nonattainment areas that request an extension under CAA Section 188(e) are required to demonstrate that the attainment plan includes the Most Stringent Measures (MSM). U.S. EPA defines MSM as:

> "The maximum degree of emission reduction that has been required or achieved from a source or source category in any other attainment plans or in practice in any other states and that can feasibly be implemented in the area seeking the extension."

U.S. EPA notes that, "in some cases it may be possible for the MSM requirement to result in no more controls and no more emissions reductions in an area than result from the implementation of BACM and BACT." This is because the approach to identify potential MSM largely follows that of a BACM/BACT analysis except that more stringent criteria must be applied to reject Potential Control Measures (PCMs) based on technological or economic infeasibility. Therefore, staff first conducted a BACM/BACT analysis to identify a list of PCMs which were then analyzed by applying MSM criteria as detailed in the Control Measure Assessment section.

The 2016 AQMP included a BACM demonstration, which served both the 2006 and 2012 PM2.5 NAAQS. U.S. EPA approved the BACM demonstration for all sources of direct PM2.5 and PM2.5 precursors for the purposes of the 2006 PM2.5 NAAQS in accordance with the requirements of CAA Section 189(b)(1)(B) and 40 CFR 51.1010.[3] As this represents the latest approved BACM demonstration for a PM2.5 NAAQS for the Basin, it was used as a starting point for this BACM demonstration. This demonstration sought to build upon and update the 2016 AQMP BACM demonstration, reflecting recent improvements in control technologies and identifying potential areas for improvements in South Coast AQMD rules. The analysis began with an overview of key PM stationary source categories which were identified through an examination of the emissions inventory. The applicable South Coast AQMD rules and corresponding rules in other air districts were also evaluated. Next, a multi-step process involving an evaluation of a wide range of sources was conducted to identify a list of PCMs. Finally, the PCMs were assessed for their technological and economic feasibility in the Control Measure Assessment section.

Identifying Key PM Source Categories

U.S. EPA recommends that the BACM analysis begin with a current detailed emissions inventory of the various sources that emit direct PM2.5 and PM2.5 precursors. Chapter 3 and Appendix III present a comprehensive emissions inventory which satisfies U.S. EPA's requirements. For the purposes of

[3] 84 FR 3305

demonstrating BACM, control measures targeting only PM2.5, NOx, and NH3 were considered. However, although NOx and NH3 emissions contribute to PM2.5, air quality modeling demonstrates that direct PM2.5 emissions have the greatest impact on ambient PM2.5 concentrations. Therefore, identifying the top stationary source categories of direct PM2.5 emissions was taken as the first step and presented in Figure III-1.

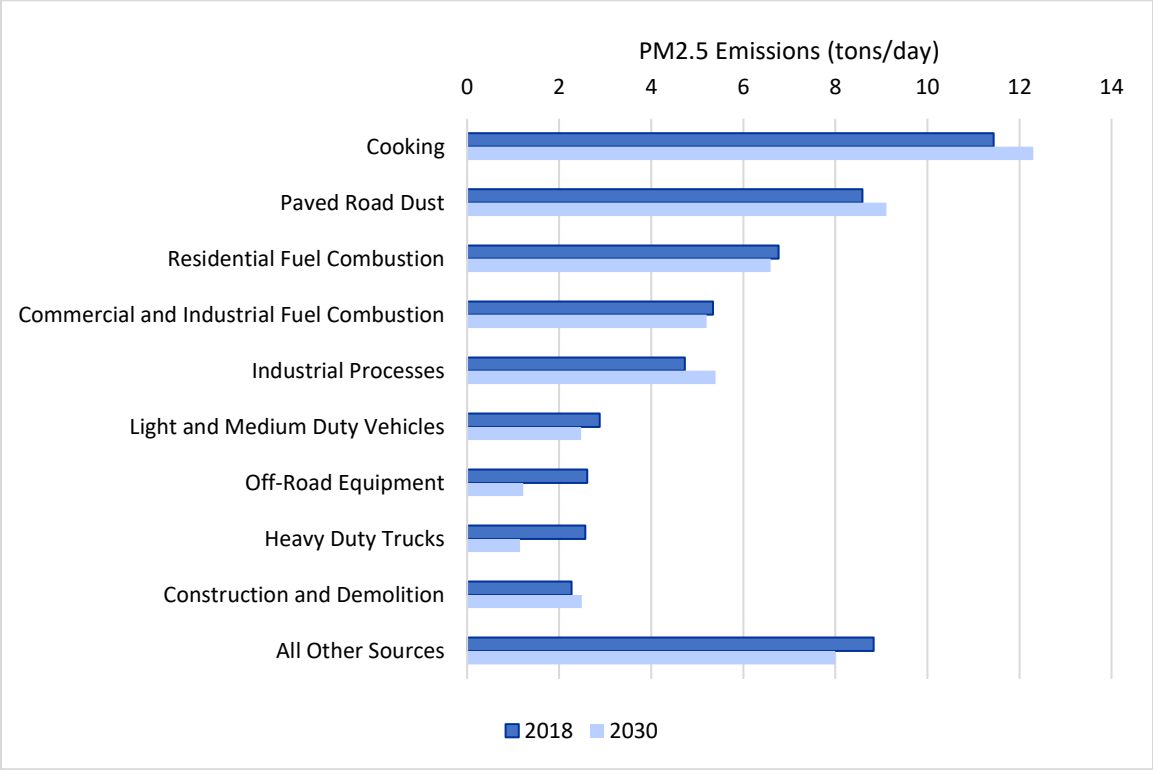

FIGURE III-1
TOP STATIONARY SOURCE CATEGORIES OF DIRECT PM2.5 EMISSIONS IN 2018 AND 2030

The top three stationary source categories are cooking, paved road dust, and residential fuel combustion. Emissions from the latter category are dominated by wood combustion while cooking emissions are dominated by restaurant charbroilers. Based on this analysis, staff selected the following three stationary source categories for an in-depth control measure analysis:

- Residential Wood Combustion
- Paved Road Dust
- Commercial Cooking

In addition, Farming Operations – Livestock Waste, was selected as a key PM stationary source category after staff became aware of U.S. EPA's proposed disapproval of several plan elements in San Joaquin Valley Air Pollution Control District's (SJVAPCD) 2018 PM2.5 Plan.[4] A central issue in U.S. EPA's proposed

[4] 87 FR 60494

disapproval relates to SJVAPCD's BACM analysis for NH3 control measures at Confined Animal Facilities. Livestock waste is the primary NH3 emission source at these facilities. Staff determined that an in-depth evaluation of existing rule requirements was warranted for this source category.

Existing Rules and Potential Control Measures for Key PM Source Categories

Existing rule requirements for the four key stationary sources identified in the previous section are summarized below. PCMs were identified by comparing existing control measures to the requirements in federal and state regulations and guidance, as well as the analogous rules in other air districts and agencies.

Residential Wood Combustion

Existing rule

South Coast AQMD Rule 445 Wood-Burning Devices (Amended October 27, 2020)

Rule 445 was first adopted in 2008 to reduce the emissions of particulate matter from wood-burning devices. The rule establishes requirements for the sale, operation, and installation of these devices. Specifically, Rule 445:

- Prohibits the installation of wood burning devices in new developments;
- Requires that wood-burning devices sold or installed for existing residential and commercial developments (additions, remodels, etc.) to be U.S. EPA certified or equivalent;
- Prohibits the burning of any product not intended for use as a fuel (e.g., trash) in a wood-burning device and requires commercial firewood sellers to only sell seasoned firewood (20 percent or less moisture content) from July through February; and
- Imposes a mandatory winter burning curtailment program that extends from November 1 through the end of February.

In addition to these regulatory requirements, South Coast AQMD has also implemented the Healthy Hearths™ program that includes a comprehensive education and outreach effort as well as financial incentives to encourage the public to switch to cleaner, gaseous-fueled hearth products.[5] This program has incentivized the conversion of more than 10,000 wood-burning fireplaces to gas or electric fireplaces and continues to provide up to $1,600 per unit for low-income households.

[5] http://www.aqmd.gov/home/programs/community/community-detail?title=wood-device-incentive-program

South Coast AQMD continues to implement a wood-burning curtailment program through Rule 445. As a consequence of *Bahr v. EPA*, 836 F.3d 1218 (9th Cir. 2016), Rule 445 was amended in June 2020 to establish PM2.5 contingency provisions that would be automatically triggered in the event that the U.S. EPA determines that the Basin failed to meet any RFP requirement, meet any quantitative milestone, submit a quantitative milestone report, or attain a PM2.5 NAAQS by the attainment date. The amendment also expanded the curtailment program to the entire Basin instead of using a source-receptor specific approach. U.S. EPA's finding of failure to attain the 2006 24-hour PM2.5 standard by 2019 triggered the contingency provision and lowered the curtailment threshold from 30 to 29 µg/m^3.[6] In October 2020, the rule was amended to add ozone contingency provisions that would be triggered in the event that the U.S. EPA determines that the Basin failed to meet an RFP milestone or attain an ozone NAAQS by the applicable deadline. The contingency provision for applicable ozone NAAQS will expand the curtailment season from the existing November through February to September through April. U.S. EPA approved the latest amendment of Rule 445 on March 8, 2022, excluding paragraph (g), "Ozone Contingency Measures," and paragraph (k), "Penalties," as satisfying PM2.5 contingency requirements.[7]

Federal and State rules and regulations

On March 16, 2015, U.S. EPA finalized the amendments for New Source Performance Standards (NSPS) for New Residential Wood Heaters (40 CFR Part 60 Subpart AAA).[8] The 2015 NSPS significantly lowered the certification emission limits for wood-burning heaters to 4.5 g/hr in Phase I (on or after May 15, 2015) and 2.0 g/hr in Phase II (on or after May 15, 2020). In April 2020, U.S. EPA amended the 2015 NSPS for New Residential Wood Heaters to include minimum requirements for pellet fuels, sell-through provisions, and a clarification of prohibited fuels.[9] The PM emission limits remained unchanged. Rule 445 references the NSPS for emission standards in the definition of U.S. EPA certified wood-burning heaters and is therefore as stringent as the newly promulgated NSPS.

Colorado, Idaho, Michigan, Oregon, Washington, Wisconsin, and Vermont require or provide incentives for cleaner wood-burning devices.[10] Oregon requires that uncertified solid fuel burning devices located at a residential property be removed, destroyed and reported to the state when the home is sold.[11] However, heating devices (e.g., fireplaces, masonry heaters, central furnaces, etc.) are exempt.

Analogous rules in other air districts

SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters (Amended June 20, 2019)

San Joaquin Valley Air Pollution Control District (SJVAPCD) Rule 4901 includes a tiered mandatory curtailment program that establishes different curtailment thresholds for each county based on the type

[6] 85 FR 57733
[7] 87 FR 12866
[8] 80 FR 13672
[9] 85 FR 18448
[10] https://www.epa.gov/burnwise/ordinances-and-regulations-wood-burning-appliances
[11] https://www.oregon.gov/deq/FilterDocs/10aq011heatsmart.pdf

of devices. During a level one episodic wood-burning curtailment, operation of wood-burning fireplaces and unregistered wood-burning heaters is prohibited, but properly operated, registered wood-burning devices are allowed to be used. During a level two episodic woodburning curtailment, operation of any wood-burning device is prohibited. In the ''hot spot'' counties of Madera, Fresno, and Kern, the level one PM2.5 threshold is 12 µg/m^3, and the level two PM2.5 threshold is 35 µg/m^3. In the remaining counties in the San Joaquin Valley (San Joaquin, Stanislaus, Merced, Kings, and Tulare), the level one PM2.5 threshold is 20 µg/m^3, and the level two PM2.5 threshold is 65 µg/m^3. Areas within the San Joaquin Valley that do not have natural gas service are not subject wood burning curtailment.

Rule 4901 prohibits the sale or transfer of any real property which contains wood-burning heaters (i.e., wood stove, pellet-fueled wood burning heater, or wood burning fireplace insert) that are not U.S. EPA Phase II certified. Rule 4901 also prohibits remodeling of a fireplace or chimney where the total cost exceeds $15,000 and a local building permit is required, unless a gas-fueled, electric, or U.S. EPA certified device is installed that meets requirements in Title 40 CFR Part 60 Subpart AAA. Finally, wood-burning fireplaces are not allowed to be newly installed in areas with natural gas service at or below 3,000 feet elevation.

SMAQMD Rule 417 Wood Burning Appliances (Adopted October 26, 2006)

Staff evaluated the requirements of Sacramento Metro Air Quality Management District (SMAQMD) Rule 417 and found no requirements that were more stringent than those already incorporated in Rule 445.

BAAQMD Regulation 6 Rule 3 Wood-Burning Devices (Amended November 20, 2019)

Under Bay Area Air Quality Management District (BAAQMD) Regulation 6-3, the BAAQMD can issue a Winter Spare the Air Alert and require a Mandatory Burn Ban when air quality is forecast to be unhealthy due to elevated levels of fine particulate matter with some exemptions that allow wood-burning. The rule provides for limited exemptions in the following areas: (i) sole source of heat, (ii) non-functional, permanently installed heater, and (iii) loss of natural gas and/or electric power. In 2019, BAAQMD revised its wood-burning rule to provide for curtailments year-round with a curtailment threshold of 35 µg/m^3. Regulation 6-3 prohibits remodeling of a fireplace or chimney where the total cost exceeds $15,000 and a local building permit is required, unless a gas-fueled, electric, or U.S. EPA certified device is installed that meets requirements in Title 40 CFR Part 60 Subpart AAA. Regulation 6-3 requires exempt households whose sole source of heat is a wood-burning device to have U.S. EPA certified devices.

Utah Wood Burning Curtailment Program – Department of Environmental Quality's Division of Air Quality Utah Administrative Code R307-302 Solid Fuel Burning Devices

The Utah wood burning curtailment program is geographically based with curtailment limited to the nonattainment counties of Box Elder, Cache, Davis, Salt Lake, Tooele, Utah, and Weber. The curtailment threshold is set at 25 µg/m^3 PM2.5 24-hour concentration. Similar to SJVAPCD Rule 4901, only counties specified in the public notification of curtailment are required to curtail wood burning.

Puget Sound Clean Air Agency Article 13: Solid Fuel Burning Device Standards (Adopted 11/10/88, amended 10/25/12) or Chapter 173-433 Washington Administrative Code

For the Tacoma-Pierce (TP) region, curtailment is limited based on device certification and location. TP certified stoves are those certified by U.S. EPA or Oregon state which can be up to 25 years old. Curtailment is classified as Stage 1 or Stage 2 air quality burn bans. Under Stage 1, where a PM2.5 ambient concentration of 35 μg/m^3 within a 48-hour time is forecast, uncertified wood-burning device use is prohibited for King and Kitsap counties. Additionally, a Stage 1 curtailment applies to Pierce and Snohomish counties if a PM2.5 ambient concentration of 30 μg/m^3 within a 72-hour time is forecast. As of October 2015, the sale or use of uncertified wood stoves is prohibited, so Stage 1 burn bans would mostly apply to fireplaces. A Stage 2 air quality burn ban, which includes all device types, may be declared if air quality is worsening rapidly. Air quality bans are also geographically based in that they may be called on a county and sub-county level. Pierce county now has three different air quality burn ban zones, that can be declared independently for burn day bans.

City of Portola, Plumas County, Wood Burning Rule – Chapter 15.10 of the City of Portola Municipal Code (Amended 10/13/21)

The City of Portola has a wood stove and fireplace ordinance which mandates episodic wood-burning curtailment from November to February whenever the Northern Sierra AQMD determines that the 24-hour average PM2.5 concentrations may exceed 30 μg/m^3 and when adverse meteorological conditions are expected to persist. The ordinance contains a contingency provision which was recently triggered due to the Plumas County nonattainment area failing to attain the 2012 annual PM2.5 standard.[12] The contingency provision expanded the curtailment season to September through April and lowered the curtailment threshold to 20 μg/m^3 when adverse meteorological conditions are expected to persist. The contingency provision will remain in effect until a new attainment plan addressing the 2012 annual PM2.5 standard is submitted to U.S. EPA.

Evaluation

Staff identified multiple provisions in other districts' rules which are potentially more stringent than those in South Coast AQMD Rule 445. Analyses of each of those provisions are presented below.

1. The curtailment threshold of 29 μg/m^3 is higher than that in other districts' rules.

The level one curtailment thresholds in SJVAPCD Rule 4901 are lower than the curtailment threshold in South Coast AQMD Rule 445. However, in contrast to the county-specific approach in Rule 4901, the prohibition on wood-burning in Rule 445 is Basin-wide and applies to all solid fuel devices, regardless of certification. Rule 4901 permits the operation of U.S. EPA certified and registered wood-burning heaters during a level one curtailment period. Similarly, the City of Portola municipal code chapter 15.10 permits the operation of U.S. EPA certified wood-burning devices during curtailment.

[12] 87 FR 80076

The differences in regulatory approaches make a direct comparison between Rule 445 and other agencies' rules difficult as a quantitative matter. However, some general inferences can be made to assess the stringency of different rules qualitatively. For example, direct comparison between Rule 445 and SJVAPCD Rule 4901 requires looking at SJVAPCD's full curtailment (65 µg/m^3 threshold) to account for both all device types and all geographic locations, as Rule 445 does (at a 29 µg/m^3 threshold). In the Basin, for the years 2016 through 2019, the PM2.5 24-hour ambient concentration exceeded 65 µg/m^3 two days during the wood-burning season, and exceeded the 35 µg/m^3 standard on 56 days, including 7 days when PM2.5 concentrations were affected by wildfire smoke. With 480 days during the Basin's wood-burning season between 2016 and 2019, this represents only 0.4 percent and 12 percent of the days, respectively, that a No-Burn Day would have been declared if SJVAPCD Rule 4901 Level Two Episodic requirements were in effect in the Basin. In contrast, South Coast AQMD declared no-burn days, which applied to the entire Basin, on 22 percent of days during the same period. Since Rule 445 does not differentiate between registered or unregistered devices or individual counties, if a SJVAPCD Level Two Episodic Curtailment were in effect in the Basin, it would have resulted in fewer curtailment days and consequently an increase in ambient PM2.5 emissions. The curtailment exemption for areas without natural gas service is another issue to consider. While Rule 445 contains a similar exemption, the South Coast Air Basin is a heavily urbanized area with widespread availability of natural gas service. On the contrary, the San Joaquin Valley has larger rural and undeveloped areas, and a significant portion of those areas do not have natural gas service. For example, most residences in Madera County do not have natural gas service.[13] Therefore, although the exemption itself is similar, San Joaquin Valley likely has a higher proportion of the population that qualifies for this exemption and therefore greater amounts of wood burning occur in the San Joaquin Valley on curtailment days.

Staff also evaluated wood burning curtailment programs implemented in other jurisdictions. Although Utah's curtailment is nominally lower (25 µg/m^3) than the Basin's, only counties specified in the public notification of curtailment are required to curtail wood burning. In this regard, Utah's program is similar to that in SJVAPCD and is less stringent than the Basin-wide approach in Rule 445. BAAQMD has a similar curtailment approach as South Coast AQMD (not limiting either device type or location), but BAAQMD has a higher curtailment threshold (35 µg/m^3). The City of Portola municipal code chapter 15.10 is less stringent in several ways compared to Rule 445. First, certified devices are exempt from curtailment. Additionally, curtailment requires not only that forecasted PM2.5 exceed a numeric value but also that adverse meteorological conditions will persist as determined by the National Weather Service. Rule 445 does not have a provision requiring the persistence of adverse meteorological conditions. Additionally, the contingency measure in Portola's code, which temporarily lowered the threshold to 20 µg/m^3, will sunset once a new attainment plan is submitted to the U.S. EPA and the threshold will revert to 30 µg/m^3. Rule 445 does not contain a sunset provision for contingency measures.

As a whole, South Coast Rule 445 is at least as stringent as wood-burning curtailment rules adopted in other areas since no wood-burning device (registered or unregistered, or in any geographic location) may be operated on any day during the wood-burning season if the ambient PM2.5 24-hour concentration is

[13] https://ww2.valleyair.org/media/jkhaefnp/06-pm25-contingency-measure-sip-revision.pdf

forecast to equal or exceed 29 μg/m^3. In addition, a quantitative analysis, presented in Attachment C, was conducted to provide a robust comparison of the curtailment programs in Rule 445 and SJVAPCD Rule 4901.

2. The wood-burning curtailment season in Rule 445 (November-February) is narrower than that in BAAQMD Regulation 6, Rule 3 (year-round).

The majority of wood-burning activities in the Basin occur during November-February with reduced activity during the shoulder months of September, October, March and April. Rule 445 has a contingency provision to expand the curtailment season to the shoulder months. The contingency provision to extend the curtailment season will be triggered upon the issuance of a final determination by U.S. EPA that the South Coast Air Basin has failed to:

> (A) meet a Reasonable Further Progress (RFP) requirement in an approved attainment plan for an applicable ozone NAAQS; or
>
> (B) attain an applicable ozone NAAQS by the applicable attainment date.

The Basin, due to its climate, has virtually no residential wood-burning during the summer and, as such, expanding the curtailment program year-round would have no air quality benefit. This is supported by temporal allocation factors used in air quality modeling which reveal that there are no residential wood burning emissions for May-September. Conversely, the climate within the BAAQMD jurisdiction is appreciably cooler during the summer and wood-burning is more prevalent year-round (see Figure III-2).[14] Given that difference, a year-round wood-burning curtailment program would be expected to yield additional emission reductions in the BAAQMD, but not in the Basin.

[14] National Weather Service. https://www.weather.gov/wrh/Climate?wfo=mtr

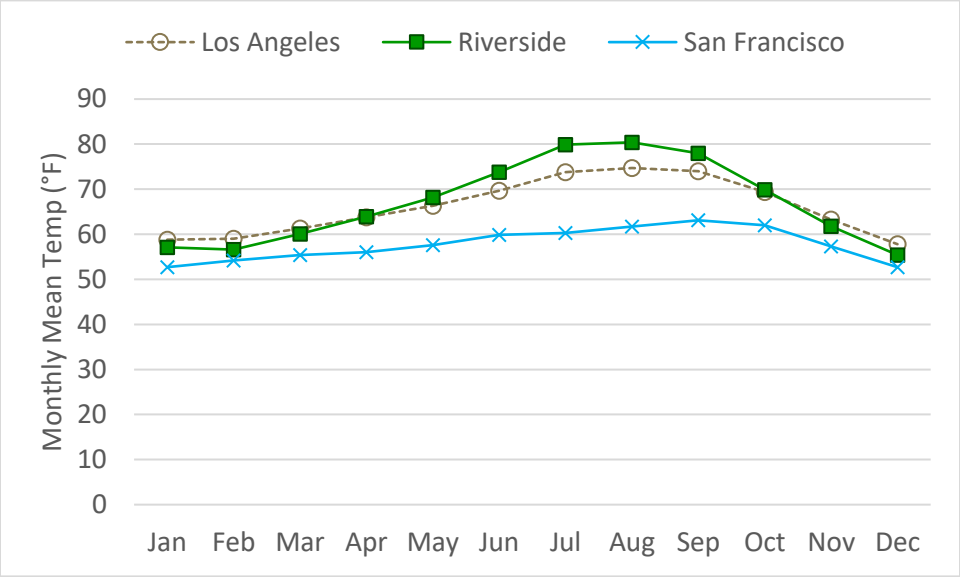

FIGURE III-2
MONTHLY MEAN TEMPERATURE IN LOS ANGELES, RIVERSIDE, AND SAN FRANCISCO BASED ON 2000-2023 DATA

Overall, Rule 445 is as stringent as BAAQMD's Regulation 6, Rule 3 since virtually no reductions will be achieved from a year-round curtailment due to the lack of wood-burning activities during summer months.

3. Other districts do not have a low-income exemption for households with an alternative source of heat.

Removal of the low-income exemption was identified as a control method to reduce PM emissions and it is evaluated further in the Appendix IV-A BCM-18.

4. Rule 445 contains an exemption from curtailment requirements for devices above 3,000 feet.

Due to atmospheric dynamics and transport, emissions from mountain communities above 3,000 feet likely have minimal to no impact on air quality in populated communities in the Basin. This is especially true on cold winter nights since a shallow boundary layer that is only a few hundred feet deep or less is present. Any emissions from the mountain communities above 3,000 feet will enter the residual layer and will not entrain down to the surface layer due to thermal stratification. On the next day when the mixing layer is developed and entrained to the residual layer, prevailing surface wind shifts to onshore flow (from the sea toward mountain summit), which will disperse the wood smoke laden air further away from the Basin.

Additionally, rural mountain communities in the Basin above 3,000 feet experience significant challenges in heating their homes during winter, especially those that may not have access to reliable natural gas or electricity service. Therefore, removing this exemption would jeopardize public safety as homes can become snowed in and residents must have a reliable means to heat their homes.

One option staff considered involved requiring U.S. EPA certified devices to qualify for the elevation-based exemption from curtailment. However, there are concerns as to whether households in rural mountain communities have the financial resources to procure and install such devices as many of these households are likely low-income. The cost concern is further elaborated under item 5. Staff does not consider it economically feasible to mandate U.S. EPA certified devices to qualify for the exemption.

5. Rule 445 does not have a provision requiring U.S. EPA certified devices to qualify for the sole source of heat exemption.

Data suggests that a very limited number of households in the Basin use wood as a fuel. In Los Angeles County, approximately 5,914 households burn wood as a primary source of heat out of an approximate total of 3,375,587 households (0.18 percent) according to U.S. Census data.[15] The limited applicability of the sole-source of heat exemption suggests that the small emission reductions from requiring these households to have U.S. EPA certified devices would have an inconsequential impact on air quality. Additionally, many households subject to the sole source exemption are low-income and therefore do not have the financial resources to purchase a U.S. EPA certified wood stove. Costs for these units vary but can easily exceed $4,000 without considering installation costs. If the wood stove is replacing an existing unit, then installation costs depend on the condition and compatibility of the exhaust pipe. If a new pipe is required, installation costs can exceed $2,000. The high cost burden for low-income households combined with the minimal emission reductions that would be achieved suggest that this measure is not economically feasible.

6. Rule 445 does not have a provision requiring replacement of uncertified devices upon transfer or sale of a property.

To enforce this provision, SJVAPCD Rule 4901 requires sellers of residential property to submit documentation regarding the wood-burning devices located on the property even if there are none. However, the requirement to replace uncertified devices only applies to wood-burning stoves and inserts, and does not extend to fireplaces. According to the emissions inventory, 97 percent of wood-burning devices in the Basin are fireplaces. Furthermore, wood stoves and inserts tend to be more prevalent in colder and higher altitude regions. As stated in the previous section, the emissions from wood burning in these areas are not anticipated to significantly impact PM2.5 air quality in the Basin, particularly in areas already characterized by high PM2.5 levels. As such, applying the resale requirement in Rule 4901 to the Basin would not result in appreciable additional emission reductions and, for most home sales, enacting the resale provision in Rule 445 would lead to no emission reductions.

Staff is further concerned with the level of effort required for the small number of uncertified stoves and inserts in homes being sold. Given the much greater housing stock in the Basin relative to the SJVAPCD, South Coast AQMD would not have the resources to implement such a program. In addition, staff has

[15] United States Census Bureau - B25040: HOUSE HEATING FUEL - Census Bureau Table

faced strong resistance from trade and building association groups as well as realtor associations due to the high cost of mandating and enforcing such a program.

In lieu of implementing this provision, South Coast AQMD has instead focused on incentives to convert wood-burning fireplaces to gaseous fueled and will consider to expanding the program to electric devices. South Coast AQMD has incentivized the conversion of more than 10,000 fireplaces to gaseous fueled, where practicable, and continues to do so by providing up to $1,600 per unit in areas that typically see the highest concentrations of ambient PM2.5. The voluntary incentive program is currently being successfully implemented and staff is exploring ways to expand eligibility criteria to further encourage voluntary participation. Since the resale provision in Rule 4901 does not require removal or upgrade of fireplaces, the incentive approach has been more effective at achieving emission reductions in the Basin.

7. Rule 445 does not have provisions addressing major remodels of fireplaces and chimneys.

SJVAPCD Rule 4901 requires installation of a U.S. EPA certified, gas-fueled, or electric device during a remodel of a fireplace or chimney that exceeds $15,000 and requires a building permit. BAAQMD Regulation 6-3 has a similar provision. Under Rule 445, remodels are permitted if a health or safety issue exists and the wood-burning device is repaired within its existing footprint.[16,17] However, Rule 445 does not have explicit provisions addressing major remodels of fireplaces or chimneys unlike rules in other air districts.

The provisions in other districts' rules referencing remodels that exceed $15,000 and require a building permit suggest a substantial change to the appearance and/or functional utility of the fireplace. An example of such a change would be a homeowner who intends to demolish an existing fireplace to install a larger fireplace. In this instance, Rule 445 section (d)(2) is as stringent as, if not more stringent than, SJVAPCD Rule 4901 section 5.3 and BAAQMD Regulation 6, Rule 3 section 307 by requiring replacement units to be a U.S. EPA certified insert, masonry or pellet fueled heater, or a gaseous-fueled fireplace. Masonry and pellet fueled stoves have very low emission factors similar to U.S. EPA certified units. Importantly, Rule 445 does not have an up to $15,000 cost exemption or building permit requirement to trigger the requirements under (d)(2). Rule 445 always requires a less polluting alternative when replacing any wood burning device. Rule 445 is also more stringent because it prohibits the sale or installation of anything other than the listed types, which applies regardless of the size of project or whether it needs a building permit. Rule 445 is likely more enforceable as a sale/installation ban, imposed on companies, than provisions addressing individual residential building projects.

[16] http://www.aqmd.gov/docs/default-source/rule-book/support-documents/rule-445/detailed-rule-445-information.pdf?sfvrsn=13

[17] South Coast AQMD, Final Staff Report for Proposed Amended Rule 445 – Wood-Burning Devices. June 5, 2020

Farming Operations – Livestock Waste

Existing rules

Emissions from livestock waste in farming operations are regulated by Rules 223 and 1127.

South Coast AQMD Rule 223 Emission Reduction Permits for Large Confined Animal Facilities (Adopted June 2, 2006)

Rule 223 requirements apply to large Confined Animal Facilities (CAFs) above certain size thresholds. Dairies with at least 1,000 milking cows, poultry facilities with at least 650,000 birds, and horse facilities with at least 2,500 horses qualify as large CAFs. Pertaining to manure management, the dairy provisions require that owners/operators implement at least six of 12 corral measures, two of seven solid manure or separated solids handling measures, one of eight liquid manure handling measures, and two of four land application measures. A poultry large CAF owner/operator must implement at least one of seven solid manure or separated solids handling measures, and one of eight liquid manure handling measures.

South Coast AQMD Rule 1127 Emission Reductions from Livestock Waste (Adopted August 6, 2004)

Rule 1127 was adopted on August 6, 2004 to reduce emissions of ammonia, VOC, and PM10 emissions from dairy livestock waste. Rule 1127 applies to dairy farms with 50 or more cows, heifers, and/or calves and to manure processing operations, such as composting operations and anaerobic digesters. Rule 1127 requires the implementation of Best Management Practices (BMPs) to minimize fugitive dust, ammonia, and VOC emissions. Manure disposal is permitted only if the destination is a manure processing facility designed to reduce ammonia and VOC emissions from unprocessed manure, agricultural land within the South Coast AQMD approved for the spreading of manure, or a combination of the above options.

Federal and State rules and regulations

There are no federal or State regulations describing BACM for this source category. However, in 2017, U.S. EPA and the United States Department of Agriculture (USDA) published a reference guide that provides a compilation of control measures that achieve emission reductions from livestock and poultry operations.[18]

Analogous rules in other air districts

SJVAPCD Rule 4570 Confined Animal Facilities (Amended October 21, 2010)

Rule 4570 limits emissions of VOC and NH3 from Confined Animal Facilities. Rule 4570's regulatory thresholds include facilities with at least 500 milking cows, 3,500 beef cattle, 7,500 calves, heifers, or other cattle, 400,000 heads of chicken and ducks, 100,000 heads of turkey, 3,000 heads of swine and horses, and 15,000 heads of sheep, goats, or any combination of the two. Rule 4570 is more stringent regarding applicability than Rule 223 for milk cows (1,000 milk cows in South Coast AQMD vs. 500 milk cows in

[18] https://www.epa.gov/sites/default/files/2017-01/documents/web_placeholder.pdf

SJVAPCD), and for chickens and ducks (650,000 birds in South Coast AQMD vs. 400,000 birds in SJVAPCD). Rule 4570 also made certain feed and housing menu items mandatory for dairies and poultry facilities. However, South Coast AQMD Rule 1127 has lower applicability thresholds for cows, heifers and/or calves. Rule 223 also has a lower applicability for horse facilities (2,500 in South Coast AQMD vs. 3,000 in SJVAPCD), however there are no CAFs with greater than 2,500 horses in San Joaquin Valley.[19]

For corral mitigation measures in dairy operations, Rule 4570 has nine mitigation measures, six of which are mandatory and one additional measure that is required from the remaining three. South Coast AQMD Rule 223 requires at least six control measures from 10 Class One mitigation measures and two Class Two mitigation measures. For one Class One mitigation measure – inspect water pipes and troughs and repair leaks – South Coast AQMD Rule 223 has a higher frequency requirement than SJV Rule 4570. In addition, South Coast AQMD Rule 1127, which applies to dairies with 50 or more cows, requires facilities to choose at least five of the seven corral mitigation measures. Rule 4570 contains two solid waste control measures, from which facilities are required to choose at least one. South Coast AQMD Rule 223 has four Class One mitigation measures and three Class Two mitigation measures, from which facilities are required to choose at least two. With regard to liquid waste mitigation measures in dairies, operators are required to choose at least one of the four mitigation measures listed in Rule 4570. South Coast AQMD Rule 223 has five Class One mitigation measures and three Class Two mitigation measures, from which facilities are required to choose at least one. South Coast AQMD Rule 1127 requires that manure removed must be either treated at an approved manure processing operation or applied on agricultural land with local approval.

BAAQMD Regulation 2 Rule 10 Large Confined Animal Facilities (Adopted July 19, 2006)

Rule 2-10 is a permit rule that limits emissions of VOCs, NOx and PM10 from large CAFs. The applicability threshold is the same as in South Coast AQMD Rule 223. Rule 2-10 requires Reasonably Available Control Technology (RACT) to be implemented for a large CAF.

SMAQMD Rule 496 Large Confined Animal Facilities (Adopted August 24, 2006)

Rule 496 applies to large CAFs with the same regulatory threshold as South Coast AQMD Rule 223. Regarding corral mitigation measures in dairies, Rule 496 has 15 Class One mitigation measures and three Class Two mitigation measures from which facilities are required to choose at least six. South Coast AQMD Rule 223 requires the same number of control measures (at least six) from ten Class One mitigation measures and two Class Two mitigation measures. For controlling emissions from solid waste, Rule 496 requires the dairy operators to choose at least two mitigation measures from five Class One mitigation measures and three Class Two mitigation measures; South Coast AQMD Rule 223 has four Class One mitigation measures and three Class Two mitigation measures, from which facilities are required to choose at least two. Regarding liquid waste mitigation measures, Rule 496 has five Class One mitigation measures and five Class Two mitigation measures, from which facilities are required to choose at least

[19] San Joaquin Valley Air Pollution Control District 2018 Serious Area Plan for the 2012 Annual PM2.5 Standard, Appendix C. https://www.valleyair.org/pmplans/documents/2018/pm-plan-adopted/C.pdf

one. South Coast AQMD Rule 223 has similar requirements at which operators are required to choose at least one measure from five Class One mitigation measures and three Class Two mitigation measures.

ICAPCD Rule 217 Large Confined Animal Facilities Permits Required (Amended February 9, 2016)

Imperial County Air Pollution Control District (ICAPCD) Rule 217 was adopted on October 10, 2006 and limits ammonia and VOC emissions from large confined animal facilities.[20] Following adoption of the 2016 amendment, the requirements are now equally stringent to SJVAPCD Rule 4750, and thus the applicability thresholds are lower than those in South Coast AQMD Rule 223.[21]

Evaluation

SJVAPCD Rule 4750 and ICAPCD Rule 217 have lower applicability thresholds than South Coast AQMD Rule 223. Staff evaluated the feasibility and effectiveness of lowering the rule applicability thresholds for dairies and poultry facilities. Staff also evaluated the control measures provided in the U.S. EPA and USDA reference guide. The evaluation can be found in the Control Measure Assessment section.

Paved Road Dust

Existing rules

Emissions from paved road dust are regulated by multiple South Coast AQMD rules.

South Coast AQMD Rule 1186 PM10 Emissions from Paved and Unpaved Roads and Livestock Operations (Amended July 11, 2008)

Rule 1186 controls emissions of particulate matter from paved and unpaved public roads, and livestock operations. It establishes requirements to prevent material from being deposited on roadways and also requires local jurisdictions to procure certified street sweeping equipment. Rule 1186 requires new or widened roads to be constructed with curbing or, as an alternative, paved shoulders. Local governments are also required to remove material deposited onto roads as a result of wind, water erosion, or by other means, and are also required to use only South Coast AQMD Rule 1186-certified street sweepers which have a minimum pick-up efficiency of 80 percent and limit entrained PM10 emissions to no more than 200 mg/m. Rule 1186 also requires unpaved access connections and unpaved feed lane access areas in livestock operations to be treated. All grinding activities are limited to 2 to 5 p.m. if visible emissions are detected.

[20] https://apcd.imperialcounty.org/wp-content/uploads/2020/01/1RULE217.pdf
[21] San Joaquin Valley Air Pollution Control District 2018 Serious Area Plan for the 2012 Annual PM2.5 Standard, Appendix C. https://www.valleyair.org/pmplans/documents/2018/pm-plan-adopted/C.pdf

South Coast AQMD Rule 1157 PM10 Emission Reductions from Aggregate and Related Operations (Amended September 8, 2006)

Rule 1157 requires access improvements which are intended to reduce the amount of material tracked out from a facility onto surrounding paved public roads.

South Coast AQMD Rule 403 Fugitive Dust (Amended June 3, 2005)

Rule 403 requires access improvements for sites greater than 5 acres and all material tracked out from applicable sources must be removed at the conclusion of the workday or at any time it extends more than 25 feet from a site.

South Coast AQMD Rule 403.2 Fugitive Dust from Large Roadway Projects (Adopted June 3, 2022)

Rule 403.2 reduces potential fugitive dust impacts to communities near large roadway projects and prohibits certain large roadway project activities that generate dust and are in close proximity to sensitive receptors and areas of public exposure. Rule 403.2 includes additional requirements related to dust control, notification to nearby receptors, project signage, and recordkeeping.

Federal and State rules and regulations

Staff evaluated the requirements of U.S. EPA's Fugitive Dust Background Document and Technical Information Document for BACM and found no requirements that were more stringent than those already incorporated in the South Coast AQMD rules for this source category.[22]

There are no State regulations/policies describing BACM for this source category.

Analogous rules in other air districts

SJVAPCD Rule 8061 Paved and Unpaved Roads (Amended August 19, 2004)

SJVAPCD Rule 8061 establishes a minimum sweeping frequency of once per month for roads with paved curbs that have been determined to have the greatest potential for dirt and silt loadings. For unpaved roads, on any unpaved road segment with 26 or more Annual Average Daily Traffic (AADT), the owner/operator shall limit visible dust emission to 20 percent opacity and comply with the requirements of a stabilized unpaved road or shall implement an APCO-approved Fugitive PM10 Management Plan. Within an urban area, Rule 8061 requires that all new roads be paved. For existing paved roads in urban areas with unpaved shoulders, Rule 8061 requires paving or stabilizing a 4-foot shoulder on 50% of the roads with the highest AADT.

[22] https://nepis.epa.gov/Exe/ZyPDF.cgi/2000JCJE.PDF?Dockey=2000JCJE.PDF

SMAQMD Rule 403 Fugitive Dust (Adopted August 3, 1977)

Staff evaluated the requirements of SMAQMD Rule 403 and found no requirements that were more stringent than those already incorporated in the South Coast AQMD rules for this source category.

BAAQMD has no rule for this source category.

Evaluation

Staff evaluated the feasibility and effectiveness of establishing minimum street sweeping frequencies and enhancing street cleaning for roads with higher silt loadings. The evaluation can be found in the Control Measure Assessment section.

Commercial Cooking

Existing rule

South Coast AQMD Rule 1138 Control of Emissions from Restaurant Operations (Adopted November 14, 1997)

South Coast AQMD regulates VOC and PM emissions from chain-driven charbroilers through Rule 1138. Rule 1138 covers chain-driven charbroilers cooking 875 pounds of meat or more per week, applicable to mostly large (fast food) chain operations. The rule requires the installation of flameless catalytic oxidizers, or equivalent control devices, to chain-driven charbroilers. Currently, under-fired charbroilers are not regulated by Rule 1138.

Federal and State rules and regulations

There are no federal or State regulations/policies describing BACM for this source category.

Analogous rules in other air districts and local agencies

SJVAPCD Rule 4692 Commercial Charbroiling (Amended June 21, 2018)

Rule 4692 reduces PM emissions by requiring catalytic oxidizers for chain-driven charbroilers cooking 400 pounds of meat or more per week. This threshold is more stringent than South Coast AQMD Rule 1138 which applies to chain-driven charbroilers cooking 875 pounds of meat or more per week. Rule 4692 requires that chain-driven charbroilers be equipped with a catalytic oxidizer that achieves minimum control efficiencies of 83 percent for PM10 and 86 percent for VOCs. Catalytic oxidizers certified by South Coast AQMD are also deemed compliant. In its 2018 amendment, SJVAPCD expanded Rule 4692 applicability to include under-fired charbroilers. Operators of under-fired charbroilers are required to submit a one-time report and register the equipment in lieu of obtaining a permit. There are no registration and reporting requirements for under-fired charbroilers in Rule 1138. However, there are limited filing requirements for owners or operators of commercial charbroilers under Rule 222.

BAAQMD Regulation 6, Rule 2 Commercial Cooking Equipment (Adopted December 5, 2007)

Regulation 6-2 requires controls on chain-driven charbroilers and under-fired charbroilers meeting the requirements of: exempting less than 400 lbs of meat per week for chain-driven charbroilers and exempting less than 800 lbs of meat per week for under-fired charbroilers; installation of a certified catalytic oxidizer emitting 1.3 lbs of PM10 and 0.32 lbs of VOC per 1,000 lbs of beef cooked, or a control device emitting 0.74 lbs of PM10 per 1,000 lbs of beef cooked for chain-driven charbroilers; PM10 emissions limit no more than 1.0 lb per 1,000 lbs of beef cooked and installation of a certified control device for new and existing under-fired charbroilers. These emission limits are similar to the limits that would be achieved by a South Coast AQMD certified catalytic oxidizer.

BAAQMD does have a lower exemption limit for chain-driven charbroilers (400 lb or less of beef cooked per week) in comparison to South Coast AQMD (875 lb or more per week). However, South Coast AQMD Rule 1138 is applicable to all types of meat (e.g., fish, chicken, pork, etc.). While beef (e.g., hamburger and steak) does have the highest amount of PM and VOC emissions per pound, a large portion of the overall types of meat cooked include meats other than beef. In the Bay Area, 58 percent of meat charbroiled is not beef.[23] Furthermore, the BAAQMD exemption threshold of 800 lb or less of beef for under-fired charbroilers is very close to the 875 lb or less exemption for chain-driven charbroilers since, at this volume of throughput, charbroilers tend to be chain-driven and not under-fired and a permit may be required.

Finally, no under-fired charbroiler emissions control device meeting the requirements of BAAQMD Regulation 6 Rule 2 has been certified in the Bay Area and there is no active enforcement of this provision.[24]

New York City Department of Environmental Protection (NYC DEP), Title 24 of the Administrative Code, Section 24-149.4 Commercial Char Broilers (Amended May 6, 2016)

Passed in May 2016, this code requires the installation of a control device which is certified to provide at least 75 percent emission reductions for new under-fired charbroilers and for any new or existing chain-driven charbroiler used to cook 875 lbs or more of meat per week. Registration and the payment of a $100 administration fee are required for existing charbroiler units. Consideration of control requirements for existing under-fired charbroilers was pushed back due to feasibility questions and higher cost of retrofitting existing operations. Based on conversations with NYC DEP, there has been no active enforcement of the under-fired charbroiler provisions in this code.

City of Aspen, Colorado, Administrative Code Section 13.08.100. Restaurant Grills

This code applies to commercial charbroilers installed after April 25, 1983. Charbroilers installed after April 25, 1983 but before January 1, 1993 are required to be equipped with an emission control device that reduces uncontrolled PM10 emissions by at least 90 percent if the charbroiler is used to cook high-

[23] 2007 Bay Area Air Quality Management District Staff Report, Regulation 6, Rule 2: Commercial Cooking Equipment

[24] Telephone call with Eric Pop, BAAQMD, 5/5/23

fat-content meat. All charbroilers newly installed on or after January 1, 1993 are subject to PM10 emissions control at 90 percent efficiency, unless a charbroiler is replaced with another charbroiler that is less than or equal to the cooking surface of the charbroiler being replaced.

Ventura County Air Pollution Control District Rule 74.25 Restaurant Cooking Operations

All chain-driven charbroilers cooking over 875 lbs meat/week require catalytic oxidizers. Staff did not identify any more stringent provisions than those in Rule 1138.

Evaluation

Staff assessed the potential emission reduction opportunities of lowering the regulatory threshold for chain-driven charbroilers. The evaluation can be found in the Control Measure Assessment section. As of September 2023, staff confirmed that jurisdictions with measures in place that require installing control devices for under-fired charbroilers (BAAQMD and NYC DEP) do not have any known installations that meet the applicable measure requirements. As these jurisdictions were not able to identify an example of an installed certified control device, it makes it difficult to demonstrate that available technologies could achieve emission reductions in practice. Therefore, staff does not propose a potential control measure for under-fired charbroilers.

Identifying Potential Control Measures

While the previous section focused on an in-depth analysis of several key PM source categories, the BACM demonstration is required to identify potential opportunities to reduce emissions across all applicable source categories. To accomplish this, U.S. EPA recommends that nonattainment air districts first identify the emission reduction programs that have already been implemented at the federal, state or local air district level. Next, U.S. EPA recommends that air districts examine additional control measures adopted for other nonattainment areas to attain the ambient air quality standards as expeditiously as practicable. To demonstrate that South Coast AQMD has considered all available measures, a multi-step analysis that consulted various sources was conducted. The following sections summarize the analysis.

Step 1 – Other Districts' Control Measures

This portion of the analysis focused on the identification of air districts' rule requirements that are more stringent than those in South Coast AQMD rules. A detailed evaluation of South Coast AQMD rule requirements can be found in Attachment A. It shows that, in general, South Coast AQMD's current rules and regulations are equivalent to or more stringent than those developed by other air districts. However, in some areas, existing source-specific rules may be amended to lower exemption thresholds and/or emissions standards, promote cleaner technologies, or add additional best management practices. The key findings are summarized in Table III-1, while the Control Measure Assessment section contains an in-depth feasibility discussion for each measure.

TABLE III-1
AIR DISTRICTS' RULE REQUIREMENTS THAT ARE MORE STRINGENT THAN THOSE IN SOUTH COAST AQMD RULES

Rule #	Evaluation
223	SJVAPCD Rule 4570 has lower applicability thresholds than those in Rule 223 for milk cows (1,000 milk cows in South Coast AQMD vs. 500 milk cows in SJVAPCD), and for chickens and ducks (650,000 birds in South Coast AQMD vs. 400,000 birds in SJVAPCD). Staff evaluated the feasibility and effectiveness of extending rule applicability to dairies and certain poultry facilities using a lower size threshold, and the assessment can be found in the Control Measure Assessment section.
445	SJVAPCD Rule 4901 and BAAQMD Regulation 6, Rule 3 have more stringent requirements. For details, refer to the previous section. Staff analyzed the feasibility of incorporating the more stringent requirements and the assessment can be found in the Control Measure Assessment section.
1111	BAAQMD Regulation 9, Rule 4 establishes a zero NOx emission limit for new natural gas-fired space heaters with a capacity < 175,000 Btu/hr beginning in 2029, which is more stringent than the 14 ng/J NOx emission limit in Rule 1111. Staff evaluated the feasibility and effectiveness of lowering the emission limit and the assessment can be found in the Control Measure Assessment section.
1117	SJVAPCD Rule 4353 contains emission limits for PM10 which are not in Rule 1117. Staff evaluated the feasibility of incorporating these emission limits and the assessment can be found in the Control Measure Assessment section.
1121	BAAQMD Regulation 9, Rule 6 establishes a zero NOx emission limit for new natural gas-fired water heaters and boilers, which is more stringent than the NOx emission limits in Rule 1121. Implementation of the zero NOx limit follows a phased approach depending on the capacity, but all new heaters and boilers up to 2 MMBtu/hr are required to comply by 2031. Staff evaluated the feasibility and effectiveness of lowering the emission limit and the assessment can be found in the Control Measure Assessment section.
1138	SJVAPCD Rule 4692 has a lower applicability threshold (400 vs. 875 lbs of meat or more per week in South Coast AQMD) for chain-driven charbroilers. BAAQMD Regulation 6, Rule 2 applies to under-fired charbroilers with combined total grill surface area of at least 10 square feet, purchasing 1,000 lbs of beef or more per week, and cooking 800 lbs of beef per week. Staff evaluated the feasibility of lowering the regulatory threshold of chain-driven charbroilers from 875 to 400 lbs of meat or more per week and extending applicability to under-fired charbroilers. The assessment can be found in the Control Measure Assessment section.
1146	SJVAPCD Rule 4320 has more stringent NOx emission limits than Rule 1146 for boilers, steam generators, and process heaters greater than or equal to 5 MMBtu/hr. For natural gas-fired boilers between 5 and 20 MMBtu/hr, the NOx limit is 5 ppm in Rule 4320, while the corresponding NOx limits are 7 to 9 ppm in Rule 1146. In addition, for natural gas-fired units that are greater than 20 MMBtu/hr, the NOx limit is 2.5 ppm in Rule 4320 compared to 5 ppm in Rule 1146. Unlike Rule 1146, which sets mandatory emission limits, Rule 4320

Rule #	Evaluation
	has an option for facilities to pay an annual emission mitigation fee in lieu of meeting the NOx limits. Staff evaluated the feasibility of lowering emission limits in Rule 1146 and the assessment can be found in the Control Measure Assessment section.
1186	SJVAPCD Rule 8061 requires municipalities to sweep paved roads at least once per month with PM10 efficient units. For unpaved roads, on any unpaved road segment with 26 or more AADT, the owner/operator shall limit visible dust emission to 20 percent opacity and comply with the requirements of a stabilized unpaved road, or shall implement an APCO-approved Fugitive PM10 Management Plan. Within an urban area, this rule requires all new roads to be paved. Staff evaluated the feasibility of these requirements and the assessment can be found in the Control Measure Assessment section.

The following sections present an in-depth analysis of SIPs from other 2012 annual PM2.5 NAAQS nonattainment areas (see Table III-2). South Coast AQMD staff evaluated the control measures in these SIPs and analyzed the corresponding adopted or amended rules, if applicable. Evaluation of the control strategies for these nonattainment areas is a critical component of this BACM demonstration and ensures that South Coast AQMD incorporates the most effective PM2.5 measures being applied across the nation.

TABLE III-2
2012 ANNUAL PM2.5 NAAQS NONATTAINMENT STATUS AND ATTAINMENT YEAR

NONATTAINMENT AREA	2012 Annual PM2.5 Standard	
	Classification	Attainment Year
Los Angeles-South Coast Air Basin, CA	Serious	2025
San Joaquin Valley, CA	Serious	2025
Plumas County, CA	Serious	2025
Imperial County, CA	Moderate	2021
Allegheny County, PA	Moderate	2021

PM2.5 Nonattainment Areas, as of 1/30/2023, are posted in https://www3.epa.gov/airquality/greenbook/kbtcw.html

San Joaquin Valley, CA

On November 15, 2018, San Joaquin Valley APCD adopted the 2018 PM2.5 Plan to address U.S. EPA's 1997 (annual, 15 µg/m^3 and 24-hour, 65 µg/m^3), 2006 (24-hour, 35 µg/m^3), and 2012 (annual, 12 µg/m^3) PM2.5 standards.[25] The plan committed to adopt the following eight regulatory control measures.

- SJVAPCD Rule 4311 Flares

  Rule 4311 controls emissions from flares at oil and gas production facilities, sewage treatment plants, waste incineration and petroleum refining operations. Flare operators are required to submit flare minimization plans, perform extensive monitoring and record keeping, submit reports of planned and unplanned flaring activities, and meet petroleum refinery SO2 performance targets. In its 2018 PM2.5 Plan, SJVAPCD committed to pursue 0.05 tpd of additional NOx emissions reductions.

  Rule 4311 was amended on December 17, 2020 and has NOx and VOC emissions limits that are 0.018 to 0.06 lbs/MMBtu and 0.008 to 0.038 lbs/MMBtu, respectively. South Coast AQMD Rule 1118 (Control of Emissions from Refinery Flares; amended 7/7/17) requires flare minimization plans, reports of planned and unplanned flaring activities, and record keeping for petroleum refineries. South Coast AQMD Rule 1118.1 (Control of Emissions from Non-Refinery Flares; adopted in January 2019, limits NOx emissions at 0.018 to 0.06 lbs/MMBtu and VOC emissions at 0.008 to 0.038 lbs/MMBtu from non-refinery flare gases, including digester gas, landfill gas, produced gas, and other flare gas. The NOx limits in South Coast AQMD Rule 1118.1 are as stringent as those in SJVAPCD Rule 4311.

- SJVAPCD Rule 4306 Boilers, Steam Generators, and Process Heaters – Phase 3 and Rule 4320 Advanced Emission Reduction Options for Boilers, Steam Generators, and Process Heaters Greater than 5.0 MMBtu/hr.

  A wide range of industries are subject to Rules 4306 and 4320, including electrical utilities, cogeneration, oil and gas production, petroleum refining, manufacturing and industrial processes, food and agricultural processing, and service and commercial facilities. The 2018 PM2.5 Plan considered potential measures including lowering emission limits and further lowering the more stringent advanced emission reduction option limit.

  Both Rule 4306 and Rule 4320 were amended on December 17, 2020 to include the latest generation of ultra-low NOx burners, SCR, and low NOx burners combined with SCR. Rule 4306 has tiered NOx emissions requirements. Tier 1 limits are required until December 30, 2023 and Tier 2 limits are enforced beginning December 31, 2023. For Tier 1 units operated on natural gas with a rated heat input equal to or less than 20 MMBtu/hr, a NOx limit of 9 ppm for thermal fluid

[25] https://www.valleyair.org/pmplans/documents/2018/pm-plan-adopted/2018-Plan-for-the-1997-2006-and-2012-PM2.5-Standards.pdf

heaters with a total rated heat input between 5 and 20 MMBtu/hr to be implemented by 2023–2029. Rule 4320 requires fire-tube boilers and all other equipment greater than 20 MMBtu/hr to meet 2.5 ppm NOx limit by 2023.

South Coast AQMD Rule 1146 (Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters; amended 12/4/20) currently limits NOx emissions from thermal fluid heaters to 12 ppm. While 9 ppm is feasible for new burners upon replacement, the 12 ppm NOx emission limit was established at the time of rule development. Lowering the emission limit from 12 ppm to 9 ppm for retrofits involves higher costs ranging from $58,000 to $523,000 per ton of NOx reduced.[26] SJVAPCD Rule 4320 provides the flexibility to comply with the lower NOx emission limit through paying an annual mitigation fee as an option in lieu of meeting the limit, whereas the emission limits in Rule 1146 are mandatory.

- SJVAPCD Rule 4354 Glass Melting Furnaces

Rule 4354 limits emissions of NOx, CO, VOC, SOx, and PM10 from glass manufacturing plants that make flat glass (window and automotive windshields), container glass (bottles and jars), and fiberglass (insulation). SJVAPCD committed to pursue the potential reductions of NOx emissions for container glass furnaces using ultra-low NOx control technologies such as catalytic filtration, oxy-fuel combined with SCR, and other methods.

Rule 4354 was amended on December 16, 2021 and requires container glass melting furnaces to meet a 1.5 lbs of NOx limit per ton of glass produced until December 31, 2023. On and after January 1, 2024, the phase I NOx limit is 1.1 lbs per ton of glass produced and the phase II NOx limit is 0.75 lbs per ton of glass produced. For the same type of glass melting furnaces, the SOx emission limit is 1.1 lbs per ton of glass produced until December 31, 2023 and 0.85 lbs per ton of glass produced on and after January 1, 2024.

South Coast AQMD Rule 1117 (Emissions from Container Glass Melting and Sodium Silicate Furnaces; amended 6/5/20) has comparable emission limits of NOx and SOx for container glass melting furnaces. Through 2023, NOx (0.75 lbs per ton of glass produced) and SOx (1.1 lbs per ton of glass produced) emission limits in Rule 1117 are at least as stringent as or even more stringent than Rule 4354. After 2024, the NOx emission limit in Rule 1117 is as stringent as that in Rule 4354. SJVAPCD Rule 4354 has other emissions limits for CO, VOC, and PM10 which are not in Rule 1117.

[26] http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2022-air-quality-management-plan/final-2022-aqmp/appendix-vi.pdf?sfvrsn=12

- SJVAPCD Rule 4692 Commercial Charbroiling

  The control measure included in the 2018 PM2.5 Plan sought to achieve additional emission reductions from commercial under-fired charbroilers through an incentive-based approach to fund the installation of controls for commercial under-fired charbroilers within urban boundaries in hot-spot areas, with a future year regulatory requirement to encourage participation by Valley businesses. As of April 2023, only one restaurant had completed a retrofit installation of under-fired charbroiler control technology as part of the Valley's incentive program.[27]

  Rule 4692 was amended on June 21, 2018, but requirements to install controls for under-fired charbroilers were not included in the rule. The details of the rule requirements are explained in the Cooking-Commercial Charbroiling section of Existing and Potential Control Measures for Key PM Source Categories.

- SJVAPCD Rule 4901 Wood Burning Fireplace and Wood Burning Heaters

  The control measure included in the 2018 PM2.5 Plan sought potential enhancements to its wood-burning curtailment program including lowering curtailment levels, enhanced levels of incentives, prohibiting wood-burning devices in new construction, enhanced outreach and education efforts, and new requirements for significant remodels of a fireplace or chimney.

  Rule 4901 was amended on June 20, 2019. The details of the rule requirements are explained in the Residential Fuel Combustion – Wood Combustion – Wood Stoves section of Existing and Potential Control Measures for Key PM Source Categories.

- SJVAPCD Rule 4352 Solid Fuel-Fired Boilers, Steam Generators and Process Heaters

  Rule 4352 limits NOx and CO emissions from any boiler, steam generator or process heater that is fired on solid fuel including municipal solid waste (MSW), biomass, and other solid fuels.

  Rule 4352 was amended on December 16, 2021 to lower NOx limits to 110 ppm on MSW and 65 ppm on biomass and all others, averaged over 24-hours, on and after January 1, 2024. South Coast AQMD Rule 1146 sets a NOx emission limit at 40 ppm on any non-gaseous fueled unit, averaged over 15 minutes, which is more stringent than the NOx limits set in Rule 4352.

- SJVAPCD Rule 4550 Conservation Management Practices (CMP)

  Rule 4550, adopted in 2004, targets fugitive particulate emissions from agricultural operations (e.g., tillage practices, land preparation activities, etc.) to bring the Valley into attainment of the PM10 NAAQS. San Joaquin Valley APCD committed to evaluate the feasibility and effectiveness of control measures to achieve additional PM2.5 emission reductions from tilling and other land

[27] Email from Kyle Matsumura, SJVAPCD on April 17, 2023

preparation activities based on the research and through additional incentives under Rule 4550. However, there have been no recent amendments to Rule 4550 that would trigger reassessment of the rule provisions as they relate to those in South Coast AQMD rules.

South Coast AQMD Rule 403 aims to reduce the amount of PM entrained in the atmosphere as a result of man-made fugitive dust sources by requiring actions to prevent, reduce or mitigate fugitive dust emissions. Rule 1186 further reduces PM emissions from livestock operations.

- SJVAPCD Rule 4702 Internal Combustion Engines

Rule 4702 applies to any internal combustion engine (ICE) rated at 25 bhp or greater and limits NOx, CO, VOC, and SOx emissions from applicable units including agricultural engines. In the 2018 PM2.5 Plan, SJVAPCD sought to further reduce NOx emissions from both agricultural and non-agricultural ICEs to the extent that such controls are technologically and economically feasible. Rule 4702 was amended on August 19, 2021 to establish emission limits for two engine ratings – one rated at least 25 bhp and up to 50 bhp and the other greater than 50 bhp. Stationary engines rated at up to 50 bhp must meet applicable requirements and emission limits specified in 40 CFR 60 Subparts IIII and JJJJ. Engines rated at greater than 50 bhp have separate emission limits by ignition type. Spark-ignited engines used in Agricultural Operations (AO) are required to meet 11 ppm NOx for rich-burn by 12/31/2023 and 43 ppm NOx for lean-burn engines by 12/31/2029 or 12 years after engine installation, whichever comes later. Non-AO spark-ignited engines are required to meet as low as 11 ppm NOx for both rich-burn and lean-burn engines with a full implementation date of 12/31/2023. South Coast AQMD Rule 1110.2 applies to all stationary and portable engines over 50 bhp and requires an 11 ppm NOx limit.

Plumas County, CA

Plumas County is part of the Northern Sierra AQMD. Staff did not identify any control measures to incorporate into the 2012 annual PM2.5 BACM analysis.

Imperial County, CA

South Coast AQMD staff reviewed Imperial County APCD's 2018 PM2.5 Plan and found no control measures that can potentially be incorporated into the 2012 annual PM2.5 BACM analysis.[28]

Allegheny County, PA

Pennsylvania Department of Environmental Protection (PADEP) submitted the Allegheny County Area PM2.5 Plan[29] on September 30, 2019, on behalf of Allegheny County Health Department (ACHD), in order to meet the applicable CAA requirements for the 2012 annual PM2.5 NAAQS. U.S. EPA approved most

[28] https://apcd.imperialcounty.org/wp-content/uploads/2020/01/2018-IC-PM25SIP.pdf
[29] https://downloads.regulations.gov/EPA-R03-OAR-2020-0157-0004/content.pdf

required elements of the Allegheny County Area PM2.5 Plan, except for the contingency measures element of the plan, which U.S. EPA conditionally approved.[30] Staff reviewed the RACM analysis[31] and found the following measures to be potentially applicable to this BACM analysis.

- Commercial Cooking

  Allegheny County has no existing control requirements for commercial cooking but evaluated HEPA filters for under-fired charbroilers as a technologically feasible emission control technology. The estimated cost-effectiveness was $16,348 per PM2.5 ton reduced, and full implementation was anticipated to take 5 years. South Coast AQMD staff evaluated requiring the installation of fabric filters and other control technology for under-fired charbroilers in the Control Measure Assessment section.

- Fuel Combustion (Residential Wood)

  Allegheny County has programs in place for residential wood stove and fireplace use, including wood stove change-out and "bounty" programs to replace existing wood stoves with new EPA-certified wood stoves, and a fireplace conversion program that offers discounts for fireplace inserts. The sale, installation, or purchase of non-Phase 2 outdoor wood-fired boilers is prohibited after May 31, 2011. An outdoor "no burn" policy is also in place when Air Quality Action Days are predicted.

  Allegheny County noted in its analysis that some communities have required the removal and destruction of old wood stoves upon the sale of a home (e.g., Mammoth Lakes, CA; Washoe County, NV; and Jacksonville, OR). South Coast AQMD evaluates requiring replacement or removal of old wood-burning devices upon the sale or transfer of a property as discussed in the Control Measure Assessment section.

- Fugitive Dust

  Dust suppressant applications are currently required at various locations within Allegheny County. Technologically feasible control measures include paving unpaved roads and unpaved parking lots and prohibiting the construction of new unpaved roads. Based on 80 percent rule penetration with unpaved roads representing 24 percent of the fugitive dust inventory, 0.19 tpd of PM2.5 emission reductions were estimated with this analysis. Cost-effectiveness was calculated based on SJVAPCD Rule 8061 to range between $2,450 and $6,725 per PM2.5 ton reduced and full implementation was anticipated one year after rule enactment.

  South Coast AQMD Rule 1186 regulates vehicle trips on paved and unpaved public roads and at livestock operations and requires different control methods including certified street sweepers,

[30] 86 FR 26388

[31] https://downloads.regulations.gov/EPA-R03-OAR-2020-0157-0014/content.pdf

chemical stabilizers, and dust suppressants to reduce fugitive PM10 emissions from roads. Between 1998 and 2006, Rule 1186 required annual treatment of unpaved public roads by either paving at least 1 mile of such roads, applying chemical stabilizer to 2 miles of such roads, or limiting vehicle speeds at 15 mph and/or installing speed bumps every 500 ft on 3 miles of such roads. Maintenance is required for chemically stabilized unpaved roads, but no such maintenance is required for paved roads. Paving unpaved public or private roads with maintenance of existing paved roads and prohibiting construction of new unpaved roads within urban areas is a potential control measure and the feasibility is assessed in the Control Measure Assessment section.

Step 2 – U.S. EPA's Technical Support Documents

Newly adopted/amended rules to be incorporated into the California SIP have to be submitted for U.S. EPA's review and approval. U.S. EPA prepares Technical Support Documents (TSDs) that review the State's submittals of rules to be approved in the SIP, outline the CAA requirements for U.S. EPA to approve such submittal, and provide evaluation and recommendation for action on the State's submittals. TSDs include U.S. EPA's suggestions for future rule revisions that could be considered as potential control measures. In the 2016 AQMP, U.S. EPA's TSDs finalized by December 2015 were reviewed as part of the 2016 AQMP BACM demonstration. Staff identified the following TSDs that have been issued since the 2016 AQMP:

- Rule 1111 (Reduction of NOx Emissions from Natural Gas-Fired, Fan Type Central Furnaces; Approved March 29, 2016)
- Rule 1118 (Control of Emissions from Refinery Flares; Approved September 22, 2022)
- Rule 1118.1 (Control of Emissions from Non-Refinery Flares; Approved December 19, 2022)
- Rule 1147 (NOx Reductions from Miscellaneous Sources; Approved December 28, 2016)
- Rule 1153.1 (Emissions of Oxides of Nitrogen from Commercial Food Ovens; Approved December 28, 2016)
- Rule 1168 (Adhesives and Sealant Applications; Approved February 24, 2021)

Of these TSDs, Rules 1118, 1118.1, and 1153.1 contained suggested rule amendments by U.S. EPA.

Below are U.S. EPA's TSD recommendations for SIP-approved South Coast AQMD Rule 1118.

> "Rule 1118 subparagraph (j) provides the Executive Officer the authority to approve another ASTM method. Without further specificity regarding how this authority will be exercised, it could functionally allow for a revision of the SIP without complying with the process for SIP revisions required by the CAA. As a result, this undermines the enforceability of the submission, constitutes a SIP deficiency, and conflicts with CAA Section 110. To resolve this deficiency, we recommend that Rule 1118 be amended to remove this clause, or the district would include sufficient detail in advance of the time of approval of the SIP provision, showing that the exercise of the director's

> discretion will not interfere with other CAA requirements. Another resolution would be for the language to include a requirement that the alternative test method also is federally approved."

Rule 1118 was amended on January 6, 2023 to address U.S. EPA's concern and now includes CARB and U.S. EPA approval for ASTM standards. Below are U.S. EPA's TSD recommendations for SIP-approved South Coast AQMD Rule 1118.1.

> "The following revisions are not currently the basis for rule disapproval, but are recommended for the next time the rule is amended. In Section (d)(3)(B), an owner or operator shall submit a Notification of Intent to the Executive Officer when the flare or flare station's annual percent capacity is greater than the applicable threshold for two consecutive calendar years. According to the Final Staff Report after July 1st, 2024, most, if not all, of the flares and flare stations would have made changes to meet the thresholds listed in the rule; and ideally any exceedance of the thresholds in the rule would be uncommon. Therefore, we are recommending that in the future, after one calendar year (instead of the current 2 years) that a flare or flare station's annual percent capacity is greater than the applicable threshold listed in Table 2 – Annual Capacity Thresholds, the owner or operator shall submit a Notification of Intent to the Executive.
>
> In South Coast AQMD Rule 1118, BAAQMD Rule 12-11, BAAQMD Rule 12-12, SBCAPCD Rule 359, and SJVAPCD Rule 4311 there is a requirement that a pilot flame or an automatic ignition is operating at the time when combustible gases are vented through the flare. The NESHAP Subpart A for General Provisions § 60.18- General control device and work practice requirements and NSPS Subpart A for General Provisions § 63.11 – Control device and work practice requirements, both require flares to have a pilot flame present during flaring. Even though pilot flames or auto ignition are present during flaring in the non-refinery flares in South Coast, we recommend that this requirement be added during the next rule amendment."

Below are U.S. EPA's TSD recommendations for SIP-approved South Coast AQMD Rule 1153.1.

> "In section (c)(1), consider adopting a lower NOx limit similar to the limit in San Joaquin Valley APCD Rule 4309 for the next time rule revision. San Joaquin Valley APCD Rule 4309 (Dryers, Dehydrators, and Ovens) contains a NOx limit of 4.3 ppm at 19 percent oxygen for applicable units and is lower than the NOx emission limit of 60 ppm at 3 percent oxygen (6.5 ppm at 19 percent oxygen) in Rule 1153.1 for units run at temperatures greater than 500 °F."

Rule 1153.1 was amended on August 4, 2023 to address U.S. EPA's concerns regarding the NOx limit.

Based on the above recommendations, and considering recent rule amendments, staff did not identify any new PCMs that could be considered in this analysis.

Step 3 – Potential Control Measures from Previous Plans

BACM/BACT is a moving target that changes over time as new technologies and products become feasible and cost-effective. For this BACM demonstration, therefore, PCMs from previous plans were reassessed

considering the latest emissions inventory, current state of technology, and cost data. Staff revisited the BACM evaluation for the 2012 annual PM2.5 standard and the Reasonably Available Control Measures (RACM) evaluation for the 2015 8-hour ozone standard in the 2016 and 2022 AQMPs, respectively. From the 2016 AQMP, staff identified several PCMs that were either rejected as infeasible or were otherwise not included and adopted as control measures. From the 2022 AQMP, one potential RACM that was determined to be technologically infeasible was reassessed. All remaining measures were not applicable based on precursor demonstrations, were incorporated into rule requirements, or were included as commitment in the plan. Precursor demonstrations presented in Appendix VI of this Plan evaluated the contribution of individual PM2.5 precursor to ambient PM2.5 levels. According to U.S. EPA's guidance and their implementation rule, the precursors with less than significant contribution are allowed to exclude exempted from control strategy analysis. As VOC and SOx are not significant precursors in this PM2.5 Plan, VOC and SOx measures were not considered. Table III-3 provides a summary of all measures that were reviewed and an explanation why some measures were omitted in this BACM demonstration.

The following section provides short descriptions of the control measures that were reconsidered in this analysis. A detailed analysis for each control measure is included in the Control Measure Assessment section.

TABLE III-3
SUMMARY OF PCMS REVIEWED IN THE 2016 AND 2022 AQMPS

PCM	Applicable AQMP	Reconsidered in this BACM demonstration?	If not, reason why
Lowering NOx emission limits for boilers, steam generators, and process heaters	2022 AQMP	Yes, PCM 15	
VOC Emission Reductions from Cooling Towers	2022 AQMP	No	Precursor demonstration for VOC
Lowering NOx emission limit for commercial food ovens	2022 AQMP	No	Rule 1153.1 was amended on 8/4/2023 to address this PCM
Additional Enhancement in Reducing Existing Residential Building Energy Use	2016 and 2022 AQMPs	No	Included in control strategy; see ECC-03
Lowering VOC Emission Limit for Gasoline Bulk Terminals	2016 and 2022 AQMPs	No	Precursor demonstration for VOC
Lowering VOC Emission Limit for Auto and Light-Duty Truck Assembly	2016 and 2022 AQMPs	No	Precursor demonstration for VOC; Rule 1115 amended in

PCM	Applicable AQMP	Reconsidered in this BACM demonstration?	If not, reason why
			March 2022 to address this PCM
Lowering VOC Limits Interior Body Sprays for Metal Container, Closure, and Coating Operations	2016 and 2022 AQMPs	No	Precursor demonstration for VOC
Co-Benefits from Existing Residential and Commercial Building Energy Efficiency Measures	2016 and 2022 AQMPs	No	Included in control strategy; see ECC-02
Co-Benefit Emission Reductions from GHG Programs, Policies, and Incentives	2016 and 2022 AQMPs	No	Included in control strategy; see ECC-01
Emission Reductions from Replacement with Zero or Near-Zero NOx Appliances in Commercial and Residential Applications	2016 AQMP	Yes, PCM 1	
Emission Reductions from Cooling Towers	2016 AQMP	Yes, PCM 3	
Ammonia Emission Reductions from NOx Controls	2016 AQMP	No	Ammonia slip limits are established through permitting. Additionally, this measure is included in the control strategy; see BCM-05.
Further Emission Reductions from Agricultural, Prescribed, and Training Burning	2016 AQMP	Yes, PCM 5	
Emission Reductions from Non-Refinery Flares	2016 AQMP	No	Rule 1118.1 was adopted on January 4, 2019 to address this PCM
Further Emission Reductions from Commercial Cooking	2016 AQMP	Yes, PCM 6	

PCM	Applicable AQMP	Reconsidered in this BACM demonstration?	If not, reason why
Further Emission Reduction from Fugitive Dust Sources	2016 AQMP	Yes, PCM 7	
Further Emission Reductions from Wood Burning Fireplaces and Wood Stoves	2016 AQMP	Yes, PCM 8	
Emission Reductions from Greenwaste Composting	2016 AQMP	Yes, PCM 9	
Emission Reduction of PM from Asphalt Manufacturing	2016 AQMP	Yes, PCM 10	
Emission Reduction of PM from Wood Pulp and Paper	2016 AQMP	Yes, PCM 11	
Emission Reduction of VOC and NOx Through Reformation and Process Modification for Cutback Asphalt	2016 AQMP	Yes, PCM 12	
Emission Reductions from Manure Management Strategies	2016 AQMP	Yes, PCM 13	

Emission Reductions from Replacement with Zero or Near-Zero NOx Appliances in Commercial and Residential Applications

This measure sought emission reductions through a zero NOx standard for new commercial and residential water and space heaters. It has been updated based on recent amendments to BAAQMD Regulation 9 Rules 4 and 6. The measure examines the feasibility of introducing zero NOx emission limits following a phased approach that depends on the appliance size and type.

Emission Reductions from Cooling Towers

This measure sought reductions of PM from industrial cooling towers by requiring use of the latest drift eliminator technologies. The control measure would reduce PM2.5 emissions from evaporative cooling

towers by requiring all units to upgrade their drift eliminators to more efficient drift eliminators that keep drift losses to less than 0.001 percent of the recirculating water flow rate. Newly constructed cooling towers have demonstrated an ultra-low drift rate of 0.0005 percent. This drift rate has been achieved in practice and could be considered BACT for new construction. Although efficiency improvements are achievable through use of the newer drift eliminators, the proportion of PM2.5 in the overall drift is fairly small compared to the PM10 fraction (PM2.5 estimated at ~3 percent of PM10).

Further Emission Reductions from Agricultural, Prescribed, and Training Burning

This control measure sought further PM emission reductions from certain categories of open burning including agricultural and prescribed (e.g., forestry service) burning activities. Reducing agricultural burning by incentivizing alternatives (e.g., chipping/grinding or composting) is possible. Additional considerations were given to aligning burn prohibitions with any potential changes to the Rule 444 no burn day provisions which could further reduce open burning emissions during peak PM2.5 episodes. Burning alternatives such as chipping/grinding or composting are widely available in the Basin.

Further Emission Reductions from Commercial Cooking

South Coast AQMD Rule 1138 regulates VOC and PM emissions from restaurant operations by requiring the installation of flameless catalytic oxidizers, or equivalent control devices, to chain-driven charbroilers. Although under-fired charbroilers are another source of emissions from restaurant operations, no cost-effective control technology was identified for this type of equipment at the time of rule adoption. Staff continued efforts to find cost-effective and technologically feasible controls for the restaurant industry. Retrofitting control devices at existing restaurants may require a complete system overhaul including fire suppression, ventilation, and electrical components. The 2016 AQMP specified that this measure would serve as an attainment contingency measure. Therefore, it was not included in the attainment control strategy.

Further Emission Reduction from Fugitive Dust Sources

South Coast AQMD Rule 1186 establishes requirements to prevent material from being deposited on roadways and requires local jurisdictions to procure certified street sweeping equipment. Under Rule 1186, certified street sweepers must have a pick-up efficiency greater than or equal to 80 percent and achieve entrained PM10 emissions of less than or equal to 200 mg/m. This control measure sought further PM emission reductions from entrained road dust, one of the major direct PM2.5 sources due to the large number of roadways and high traffic volumes in the region. Most cities in the Basin have regular street sweeping schedules so the emission reduction from mandating street sweeping frequency is expected to be minimal.

Further Emission Reductions from Wood-Burning Fireplaces and Wood Stoves

Rule 445 is designed to reduce PM emissions from wood-burning devices. The rule establishes requirements for the sale, operation, and installation of wood-burning devices. This control measure

sought to include a provision that would apply to uncertified wood-burning devices during the sale or transfer of property similar to that in SJVAPCD Rule 4901.

Lowering the Curtailment Threshold in Rule 445

Under South Coast AQMD Rule 445, Basin-wide curtailment is mandatory when PM2.5 concentrations are forecast to exceed 29 µg/m³ from November through February. The South Coast AQMD curtailment threshold applies to all solid fuel devices, including wood-based residential cooking devices. This control measure sought to evaluate the feasibility of lowering the curtailment threshold to achieve further emission reductions.

Emission Reduction of PM from Asphalt Manufacturing

This control measure was based on U.S. EPA's 2012 version of the Menu of Control Measures.[32] The measure estimated a control efficiency of 99 percent in an asphalt manufacturing facility equipped with a fabric filter or baghouse placed in parallel inside of an enclosure. Asphalt manufacturing in the South Coast AQMD is currently regulated under Rule 1157 and Rule 1155, which require the use of filters. Rule 1157 targets all aggregate and related operations but does not require enclosure for all transfer points and activities. However, Rule 1155 regulates all baghouses (including those at asphalt manufacturing facilities), except for those with a filter area less than 100 sq. ft. and requires no visible emissions at any time except for start-up and shutdown. Enclosures and baghouses are generally technologically feasible. The standard (0.01 gr/dscf) for baghouses in asphalt manufacturing facilities was set forth in Rule 1155 and was fully implemented in 2013.

Emission Reduction of PM from Wood Pulp and Paper

This control measure was based on U.S. EPA's 2012 version of the Menu of Control Measures.[33] The measure estimated a control efficiency of 95 percent in wood pulp and paper facilities equipped with dry/wet electrostatic precipitators (ESPs). Currently, there are five permitted recycled paper and paperboard manufacturing facilities in South Coast AQMD. An electrostatic precipitator (ESP) is predominantly used to control PM emissions from Kraft recovery furnaces used at paper manufacturing facilities that process virgin raw materials. For the recycled material manufacturing facilities, little or no PM is emitted from the pulp dryer.

Emission Reductions from Greenwaste Composting

This control measure sought emission reductions of VOC and NH3 from composting of greenwaste, foodwaste, and agricultural waste streams. Evaluated control approaches included improved emissions characterization via inventory and emission factor development, anaerobic digestion, pollution

[32] https://www3.epa.gov/ttn/naaqs/pdfs/MenuOfControlMeasures.pdf
[33] Ibid

prevention technology, and restrictions for direct applications of uncomposted, chipped or ground non-curbside greenwaste to public lands.

Reformulation and Process Modification for Cutback Asphalt

The measure sought to examine the feasibility of requiring warm-mix asphalt. Warm-mix asphalt would reduce natural gas use by an estimated 20 to 25 percent from reduced processing and transportation temperatures compared to hot-mix asphalt. Although the reduction in natural gas use was found to reduce NOx emissions, studies revealed mixed results for VOC emissions from warm-mix compared to hot-mix asphalt.

Emission Reductions from Manure Management Strategies

This measure sought NH3 emission reductions by lowering the applicability thresholds in Rule 223 to be as stringent as those in SJVAPCD Rule 4750 for confined animal facilities. It also explored the feasibility of additional mitigation measures for livestock waste to further reduce NH3 emissions.

Lowering Emission Limits for Boilers, Steam Generators, and Process Heaters

This measure is derived from the 2022 AQMP RACM demonstration and is based on the more stringent NOx limits for boilers, steam generators, and process heaters greater than or equal to 5 MMBtu/hr in SJVAPCD Rules 4306 and 4320 compared to those in Rule 1146. For details on the emission limits, refer to the discussion regarding Rules 4306 and 4320 in Step 3 - Control Measures in Other Nonattainment Areas.

Step 4 – U.S. EPA's Menu of Control Measures

The Menu of Control Measures (MCM)[34] compiled by the State and Local Programs Group within U.S. EPA's Office of Air Quality Planning and Standards, was developed to provide information useful in the development of local emission reduction and NAAQS SIP scenarios. U.S. EPA's MCM provides a broad listing of emission reduction measures to assist states in identifying and evaluating potential measures. The measures are based in part on the results of a literature review of the current and proposed measures of various air quality agencies, including CARB, California air districts, the Ozone Transport Commission, the Lake Michigan Air Directors Consortium, and others. For each source category, one or more emission reduction measures, the respective control efficiency, and cost effectiveness are provided.

At the time of writing, the MCM published on September 22, 2022 was the latest version available and it was therefore selected for this analysis. Staff reviewed the control measures for point and nonpoint sources of PM2.5, NH3, and NOx. The review identified four measures from the MCM that exceeded the requirements of existing rules, were not included in the 2022 AQMP, and were not otherwise identified as part of this BACM demonstration. The identified measures are as follows:

[34] https://www.epa.gov/air-quality-implementation-plans/menu-control-measures-naaqs-implementation

- Increasing the fuel moisture for prescribed burns
- Requiring electrostatic precipitators, fabric filters, and scrubbers for various industrial and commercial processes
- Requiring Selective Catalytic Reduction (SCR) of NOx for incinerators
- Requiring extended absorption to reduce NOx from nitric acid manufacturing

Proposed Rule 1165, Control of Emissions from Incinerators, is under development and will include NOx emission limits for incinerators consistent with the control efficiency specified in the MCM. There are no nitric acid manufacturing facilities located in the South Coast Air Basin and thus this measure was not evaluated. Staff evaluated the remaining control measures for potential emission reductions in the Basin and the assessment can be found in the Control Measure Assessment section.

Step 5 – U.S. EPA's Guidance Documents

In March 2013, the U.S. EPA revised its document "*Strategies for Reducing Residential Wood Smoke*"[35] to provide new information and tools to help state, tribal, and local air officials reduce fine particle pollution from residential wood smoke. The document provides a comprehensive list of strategies to help identify appropriate wood smoke reduction measures. A combination of regulatory, voluntary, and educational strategies is encouraged to ensure a successful wood smoke program with measurable emission reductions. U.S. EPA recommends that each area determine the most appropriate measures given the nature and extent of their problem. Table III-4 is a list of regulatory options outlined in the guidance document, and the corresponding control strategies (where applicable) in South Coast AQMD.

TABLE III-4
U.S. EPA LIST OF REGULATORY OPTIONS FOR REDUCING RESIDENTIAL WOOD SMOKE AND SOUTH COAST AQMD CURRENT CONTROL STRATEGIES

U.S. EPA Suggested List of Regulatory Options	South Coast AQMD Control Strategies
1. Wood-Burning Curtailment Programs	Rule 445 enacts a mandatory winter wood-burning curtailment when PM2.5 concentrations are forecasted to exceed 29 µg/m^3.
2. Opacity and Visible Emission Limits	South Coast AQMD Rule 401 does not have a "no visible emissions" requirement. Instead, Rule 401 requires the Ringelmann Chart No. 1 or an equivalent (10 percent) opacity limit.
3. Wood Moisture Content	Rule 445 requires a commercial firewood seller to only sell seasoned wood (≤20 percent moisture) from July 1 through the end of February the following year.

[35] https://www.epa.gov/sites/default/files/documents/strategies.pdf

U.S. EPA Suggested List of Regulatory Options	South Coast AQMD Control Strategies
4. Removal of Old Wood Stove Upon Resale of a Home	Currently, South Coast AQMD does not require the removal and destruction of old wood stoves upon the resale of a home. For further analysis of this regulatory option, refer to the discussion under Key PM Source Categories.
5. Require EPA Certification	For existing residential and commercial developments (additions, remodels, etc.), Rule 445 requires wood-burning devices sold or installed to be U.S. EPA certified or equivalent. Newly installed fireplaces must be gaseous-fueled or electric.
6. Ban the Use of Non-EPA-Certified Wood Stoves	Currently, South Coast AQMD does not prohibit the use of non-EPA certified wood stoves that have been installed in existing homes and businesses prior to the adoption of Rule 445. For further analysis of this regulatory option, refer to the discussion under Key PM Source Categories.
7. Restrictions on Wood-Burning Devices in New Construction	Rule 445 prohibits the installation of all wood-burning devices in new construction.
8. Hydronic Heater Rules	The use of hydronic heaters is very uncommon in South Coast AQMD; further restrictions on these devices would therefore not be expected to result in emission reductions.
9. Requirements for Wood-burning Fireplaces	For existing residential and commercial developments (additions, remodels, etc.), Rule 445 requires wood-burning devices sold or installed to be U.S. EPA certified or equivalent. Incentives are available to replace wood-burning devices with cleaner alternatives in some neighborhoods.
10. State/Tribal/Local Wood-Heating Emission Standards	U.S. EPA's New Source Performance Standards (NSPS) have the most stringent emission limit across the nation for residential wood heaters.
11. NSPS for New Residential Wood Heating Appliances	Rule 445 defines U.S. EPA certified heaters as those that comply with Title 40 Code of Federal Regulations, Part 60, Subpart AAA, March 16, 2015, or any subsequent revision. The NSPS for wood heating appliances are codified under this subpart.

In addition to the regulatory programs listed in Table VI-A-10, the South Coast AQMD has implemented the Healthy Hearths™ program that includes a comprehensive education and outreach effort to encourage the public to switch to cleaner, gaseous-fueled hearth products. An incentive program for cleaner hearth appliances is ongoing to encourage the public to switch to cleaner hearth products,

including gaseous-fueled devices that are exempt from burning curtailments.[36] As part of the Healthy Hearths™ initiative, the "Check Before You Burn" program is designed to protect public health by reducing harmful wood smoke from residential wood-burning from November 1 through the end of February. Daily air quality forecast information can be found online on the South Coast AQMD's "Check Before You Burn" map, through e-mail messages, or a toll-free number. Rule 445 also contains labeling requirements for commercial firewood or other wood-based fuel sellers to notify the public of South Coast AQMD's Check Before You Burn program.

Summary of Potential Control Measures

After thorough review of the above listed sources, South Coast AQMD staff identified the following PCMs for stationary sources listed in Table III-5. The PCMs were assessed for technological and economic feasibility in the Control Measure Assessment section.

TABLE III-5
POTENTIAL STATIONARY SOURCE CONTROL MEASURES

#	Potential Control Measure	Target Pollutant	South Coast AQMD Current Control	Source of Information
1	Replacement with Zero NOx Space and Water Heaters in Commercial and Residential Applications	NOx	Rules 1111 and 1121	Step 1 – Other Districts' Control Measures; Step 3 – Potential Control Measures from Previous Plans
2	Glass Melting and Sodium Silicate Furnaces	PM2.5	Rule 1117	Step 1 – Other Districts' Control Measures
3	Cooling Towers	PM2.5	Not Applicable	Step 3 – Potential Control Measures from Previous Plans
4	Livestock Waste at Confined Animal Facilities	NH3	Rule 223	Step 1 – Other Districts' Control Measures
5	Agricultural, Prescribed, and Training Burning	PM2.5	Rule 444	Step 3 – Potential Control Measures from Previous Plans
6	Commercial Cooking - Charbroilers	PM2.5	Rule 1138	Step 1 – Other Districts' Control Measures Areas; Step 3 – Potential Control Measures from Previous Plans
7	Paved Road Dust	PM2.5	Rule 1186	Step 3 – Potential Control Measures from Previous Plans
8	Wood-Burning Fireplaces and Wood Stoves	PM2.5	Rule 445	Step 1 – Other Districts' Control Measures; Step 3 – Potential

[36] http://www.aqmd.gov/home/programs/community/community-detail?title=wood-device-incentive-program

#	Potential Control Measure	Target Pollutant	South Coast AQMD Current Control	Source of Information
				Control Measures from Previous Plans
9	Organic Waste Composting	NH3	Rule 1133.3	Step 3 – Potential Control Measures from Previous Plans
10	Asphalt Manufacturing	PM2.5	Rule 1157	Step 3 – Potential Control Measures from Previous Plans
11	Wood Pulp and Paper	PM2.5	Not Applicable	Step 3 – Potential Control Measures from Previous Plans
12	Reformulation and Process Modification for Cutback Asphalt	NOx	Rule 1108	Step 3 – Potential Control Measures from Previous Plans
13	Unpaved Lots, Roads, and Shoulders	PM2.5	Rule 1186	Step 1 – Other Districts' Control Measures; Step 4 – U.S. EPA's Menu of Control Measures
14	Industrial and Commercial Combustion Processes	PM2.5	Not Applicable	Step 4 – U.S. EPA's Menu of Control Measures
15	Lowering Emission Limits for Boilers, Steam Generators, and Process Heaters	NOx	Rule 1146	Step 3 – Potential Control Measures from Previous Plans

In addition to the above analyses, SCAG, CARB, and South Coast AQMD staff have completed the following analyses to meet the requirements of the CAA:

- BACM and MSM demonstrations conducted by CARB and SCAG for mobile sources and transportation control measures are included in Appendices III-B and IV-B, respectively.

- Cost-effectiveness analyses and schedules for implementation for each of the stationary source and mobile source control measures, if available, are provided in Chapter 4, and Appendix IV-A for South Coast AQMD's control measures and Appendix IV-B for CARB's control measures, respectively.

Conclusion

As required by the CAA and U.S. EPA's PM2.5 Implementation Rule, South Coast AQMD staff evaluated and analyzed a wide range of sources to develop a comprehensive list of PCMs. PCMs from the 2016 AQMP, potential RACM from the 2022 AQMP, attainment plans in other jurisdictions, rules and regulations implemented by other air districts, and multiple resources published by U.S. EPA were

consulted. In general, South Coast AQMD's existing rules and regulations were found to require the most stringent level of control. There were, however, limited instances where rules could be strengthened to achieve further reductions. This resulted in the identification of 15 PCMs for which the technological and economic feasibility was assessed. A comprehensive assessment of all PCMs is presented in the next section of this Appendix.

CONTROL MEASURE ASSESSMENT

Introduction

The PCMs identified in the preceding section are evaluated to advance South Coast AQMD's emission control strategies. A comprehensive feasibility analysis is conducted for all PCMs. Each measure is independently assessed to determine whether it can be considered as BACM, an additional feasible measure, or MSM while complying with U.S. EPA's requirements.[37] U.S. EPA requires that BACM be adopted and the controls be partially or fully implemented within four years of reclassification to "serious" nonattainment. Since the South Coast Air Basin was reclassified effective December 2020, the area has until December 2024 to partially or fully implement BACM. If the analysis concludes that a measure cannot be feasibly implemented within this timeframe, it is reassessed as an additional feasible measure, or one that can be implemented by 2025, the statutory "serious" area attainment year. Finally, measures that cannot be implemented as either BACM or additional feasible measures are reassessed as potential MSM. While this analysis is allowed to consider technological and economic feasibility, U.S. EPA recommends that the analysis "apply more stringent criteria for determining the feasibility of potential MSM than that described for BACM and BACT."[38] Furthermore, the feasibility analysis for potential MSM must consider the longer timeframe allowed for implementation (up to 4 years after the statutory "serious" area attainment date). For measures that cannot be feasibly implemented as MSM, a reasoned justification for rejecting the potential MSM is included.

The emissions inventories, emission reduction estimates, and cost-effectiveness are based on the best information available at this time. Quantified emissions and estimated reductions are based on a variety of data sources, including, but not limited to, the emissions inventory presented in Chapter 3 and Appendix I of this Plan, South Coast AQMD's Annual Emissions Reporting program, archived equipment statistics obtained from South Coast AQMD's past rulemaking, and data libraries of public energy policy and planning agencies and utilities (e.g., California Public Utilities Commission, California Energy Commission, Southern California Edison, etc.). Staff commits to refine these estimates as new information becomes available during subsequent rulemaking and control measure implementation.

[37] 81 FR 58009
[38] Ibid

Potential Control Measure 1 - Emission Reductions from Replacement with Zero NOx Space and Water Heaters in Commercial and Residential Applications

Target Pollutant

NOx

Synopsis

This control measure, based on recent amendments to BAAQMD Regulation 9, seeks NOx emission reductions through a zero NOx standard for new commercial and residential water and space heaters. Zero NOx requirements would follow a phased approach that depends on the appliance size and type. This control measure applies to manufacturers, distributors, sellers, installers and purchasers of these appliances.

Potential Emission Reduction

The 2030 baseline inventory is 12.22 tpd of NOx for this source category.

Estimated emission reductions are 2.58 tpd by 2030.

Technological Feasibility

There are currently a wide variety of zero NOx electric heat pump water heaters and heat pump space conditioning (heating and cooling) systems available on the market that operate on a 240-volt circuit.[39,40]

A limited number of space and water heaters are also available for residences that only have 120-volt service (see Table III-6). Manufacturers are actively developing new heat pump systems and it is therefore expected that the number of new models will increase substantially over the next several years.

[39] Energy Star Certified Water Heaters. https://www.energystar.gov/productfinder/product/certified-water-heaters/results

[40] Energy Star Certified Central Heat Pumps. https://www.energystar.gov/productfinder/product/certified-central-heat-pumps/results

TABLE III-6
COMMERCIALLY AVAILABLE 120-VOLT SPACE AND WATER HEATERS

Manufacturer	Model	Type
Pioneer	WYT012ALFI19RL, WYT009ALFI19RL (and others)	Space heater
Hessaire	H12E1	Space heater
LG	LS120HXV2, LS090HXV2	Space heater
Mitsubishi	MZ-JP12WA, MZ-JP09WA	Space heater
Fujitsu	9RL2, 12RL2	Space heater
General Electric	AS09CRA, AS12CRA	Space heater
Senville	LETO series	Space heater
MRCOOL	DIY-12-HP-115B	Space heater
LBG Products	LBH12ATO, LBH09ATO	Space heater
AUX	Inverter series	Space heater
Daizuki	DXTH12C416-20	Space heater
Nyle Water Heating Systems	E8	Water heater
Rheem	ProTerra (Plug-In)	Water heater

Economic Feasibility

A comprehensive cost analysis for residential and commercial space and water heating appliances was conducted as part of the 2022 State SIP Strategy, Appendix A: Economic Analysis.[41] These measures were determined to be economically feasible with a cost-effectiveness value of $496,600/ton NOx.

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure
BACM/BACT	2.58 tpd of NOx by 2030	No	No	No
Additional feasible measure		No	No	No
MSM		Feasible	Feasible	Yes

For the purposes of satisfying MSM, this measure is included in CARB's commitment as the Zero-Emission Standard for Space and Water Heaters with implementation beginning January 1, 2030. Independent of MSM, South Coast AQMD's control measures BCM-01 and BCM-02, which overlap with CARB's measure, are also included in the PM2.5 Plan since these measures will implement before CARB's measure and also

[41] https://ww2.arb.ca.gov/sites/default/files/2022-09/2022_State_SIP_Strategy_App_A.pdf

target accelerated turnover of appliances through incentives. A comparison of South Coast AQMD control measures and BAAQMD rules targeting space and water heaters is shown in Table III-7.

TABLE III-7
COMPARISON OF SOUTH COAST AQMD CONTROL MEASURES AND BAAQMD RULES REGULATING NOX EMISSIONS FROM SPACE AND WATER HEATERS

Category	South Coast AQMD BCM-01 and BCM-02 Proposed Control	BAAQMD Rules 9-4 & 9-6
Residential Space Heating (< 175,000 Btu/hr)	(1) 0 ng/J by 1/1/2029 where feasible, 7 ng/J where not (2) incentivize zero emission technologies with a focus on electric panel upgrades needed for older homes	0 ng/J by 1/1/2029
Commercial Space Heating (> 175,000 Btu/hr)	---	---
Residential Water Heating (< 75,000 Btu/hr)	(1) 0 ng/J by 1/1/2029 where feasible, 5 ng/J where not (2) incentivize zero emission technologies with a focus on electric panel upgrades needed for older homes	0 ng/J by 1/1/2027
Commercial Water Heating (≥75,000 Btu/hr and ≤2 MMBtu/hr)	---	0 ng/J by 1/1/2031

Potential Control Measure 2 – Emission Reductions from Glass Melting and Sodium Silicate Furnaces

Target Pollutant

PM2.5

Synopsis

In the South Coast Air Basin, there are two facilities that operate a total of two container glass melting furnaces and one sodium silicate furnace. These furnaces are subject to NOx and SOx emission limits in South Coast AQMD Rule 1117; however, Rule 1117 does not enforce PM10 emission limits unlike SJVAPCD Rule 4353, which sets a limit at 0.20 lb/ton for container glass furnaces. A significant fraction of PM10

emissions from these facilities is emitted as PM2.5. This measure therefore seeks to evaluate the feasibility of requiring glass melting and sodium silicate furnaces to meet PM10 emission limits.

Potential Emission Reduction

The 2030 baseline inventory is 0.0641 tpd of PM2.5 for this source category.

Potential emission reductions are 0 tpd.

Technological Feasibility

It is technologically feasible to achieve the emission limit specified in SJVAPCD Rule 4353 for gas-fired container glass melting furnaces. The feasibility is further supported by an identical emission limit enforced at the federal level.[42] However, there are no applicable federal emission limits for sodium silicate furnaces and the PM10 emission limits in SJVAPCD Rule 4353 also do not apply to sodium silicate furnaces.

Economic Feasibility

It is economically feasible to achieve a PM10 emission limit of 0.20 lb/ton for container glass melting furnaces.

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure*
BACM/BACT	0 tpd PM2.5	Feasible	Feasible	No
Additional feasible measure		Feasible	Feasible	No
MSM		Feasible	Feasible	No

* While this measure is technologically and economically feasible in practice it is currently infeasible due to other considerations.

Other Considerations

Staff reviewed source test results, conducted between 2018 and 2022, for the two container glass furnaces and all source tests measured an emission factor ≤ 0.20 lb PM/per ton (see Table III-8). Since actual emission rates comply with both SJVAPCD Rule 4353 and the federal limit, no further emission reductions would occur by incorporating a PM10 emission limit for container glass furnaces in Rule 1117. Therefore, staff concludes that this control measure is not warranted.

[42] CFR Title 40, Chapter I, Subchapter C, Part 60, Subpart CC

TABLE III-8
PM SOURCE TEST RESULTS FOR GLASS MELTING FURNACES
AT OWENS-ILLINOIS (FACILITY ID: 7427)

Test Date	Furnace	PM Result (lb PM/ton produced)
11/9/2022	B	0.08
12/8/2021	B	0.15
10/6/2020	B	0.04
12/19/2018	B	0.05
11/7/2022	C	0.20
12/7/2021	C	0.18
10/7/2020	C	0.08
11/16/2018	C	0.06

Potential Control Measure 3 - Emission Reductions from Cooling Towers

Target Pollutant

PM2.5

Synopsis

This measure would seek reductions of PM2.5 from industrial cooling towers by requiring operators to use the latest drift eliminator technologies. Reducing PM2.5 emissions from cooling towers could involve a simple upgrade: requiring all units to install more efficient drift eliminators. These upgraded eliminators would ensure that drift losses are kept to a minimum, specifically less than 0.001 percent of the re-circulating water flow rate. This not only reduces emissions but also leads to significant water savings. Currently, industrial cooling towers are required to submit information on total dissolved solids (TDS) via a registration filing under Rule 222 - Filing Requirements for Specific Emission Sources Not Requiring a Written Permit Pursuant to Regulation II. The information that has been collected would be evaluated during the rule development process and used to allow PM2.5 emissions to be calculated. Appendix IV-A of the 2016 AQMP contained a potential control measure to reduce cooling tower PM emissions but concluded that PM2.5 emission reductions were not cost-effective. The 2016 AQMP did, however, include

Control Measure BCM-02 (Emission Reductions from Cooling Towers) so this PM2.5 Plan also includes a control measure, BCM-13, that proposes a further evaluation of cooling tower PM2.5 emissions.

In addition to the high costs, a recent study conducted for the California Energy Commission (CEC) found that cooling towers may act as scrubbers for surrounding areas and emit negative emissions of coarse particulate matter (between 2.5 and 10 microns), and potentially have the same effect on PM2.5 emissions.[43] The study also found that drift eliminators may vastly outperform their efficiency specifications. These findings should be examined prior to implementing controls.

Potential Emission Reduction

Potential emission reduction is to be determined.

Technological Feasibility

Newly constructed cooling towers have demonstrated ultra-low drift rates of 0.0005 percent. However, overall drift eliminator efficiencies and cooling tower effects on emissions in surrounding areas should be further examined prior to implementing controls.

Economic Feasibility

The 2016 AQMP included a cost estimate of $1.37 million to retrofit a local refinery cooling tower with a high efficiency drift eliminator. The reduction in total PM, PM10, and PM2.5 was also previously estimated at approximately 173, 11, and 0.4 tons per year, respectively. Cost effectiveness for BCM-02 in the 2016 AQMP was estimated at approximately $15,000 per ton of PM10, but was determined not cost-effective for reducing PM2.5 at over $400,000 per ton. Adjusting previous AQMP cost assumptions to 2022 costs would result in a cost-effectiveness estimate higher than $400,000 per ton of PM2.5. Additionally, it is possible that the cost effectiveness may be even higher if the existing drift elimination efficiencies installed at cooling towers are greater than specified, as outlined in the CEC study.

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure
BACM/BACT	TBD	Yes	No	No
Additional feasible measure		Yes	No	No
MSM		Yes	No	No

[43] Wexler, A., Wallis, C. D., Chuang, P., and Leandro, M. (2023). Assessing Particulate Emissions from Power Plant Cooling Towers. https://www.energy.ca.gov/publications/2023/assessing-particulate-emissions-power-plant-cooling-towers

Other Considerations

South Coast AQMD has determined that further evaluation is required prior to implementing this control measure. Control measure BCM-13 proposes development of an emissions inventory, equipment universe, and improved emission factors for cooling towers.

References

South Coast Air Quality Management District. (2017). 2016 Air Quality Management Plan, Appendix IV-A Stationary and Mobile Source Control Measures. (Published March 2017).

United States Environmental Protection Agency. (2015). *Compilation of Air Pollutant Emission Factors (AP-42), Fifth Edition, Volume I: Stationary Point and Area Sources, Chapter 5.1 Petroleum Refining*. https://www.epa.gov/air-emissions-factors-and-quantification/ap-42-compilation-air-emissions-factors.

Wexler, A., Wallis, C. D., Chuang, P., and Leandro, M. (2023). Assessing Particulate Emissions from Power Plant Cooling Towers. https://www.energy.ca.gov/publications/2023/assessing-particulate-emissions-power-plant-cooling-towers

Potential Control Measure 4 - Emission Reductions from Livestock Waste at Confined Animal Facilities

Target Pollutant

NH3

Synopsis

There are two components to this control measure. The first component seeks to lower the applicability threshold in South Coast AQMD Rule 223 to align with the more stringent thresholds in SJVAPCD Rule 4570 (1,000 milk cows in South Coast AQMD vs. 500 milk cows in SJVAPCD, and 650,000 birds in South Coast AQMD vs. 400,000 birds in SJVAPCD). The second component seeks to introduce more stringent requirements to reduce ammonia emissions at dairies and other Confined Animal Facilities (CAFs).

Given the larger presence of dairies and CAFs in SJV, South Coast AQMD consulted U.S. EPA's recent actions on SJVAPCD's 2018 PM2.5 SIP to develop a comprehensive list of ammonia control strategies that apply to this source category. U.S. EPA published a proposed rule on December 29, 2021 to approve SJVAPCD's 2018 Serious Area Plan for the 2012 annual PM2.5 NAAQS.[44] However, based on adverse public comments, U.S. EPA reversed course and proposed disapproval of several plan requirements on October

[44] 86 FR 74310

5, 2022.[45] A central issue in U.S. EPA's proposed disapproval relates to SJVAPCD's BACM analysis for Rule 4570. U.S. EPA referenced several research studies and guidance documents for ammonia reductions from CAFs that were not evaluated as part of the process to develop potential control measures. One of the referenced guidance documents was developed by U.S. EPA and the U.S. Department of Agriculture (USDA) in 2017 and is titled "*Agricultural Air Quality Conservation Measures: Reference Guide for Poultry and Livestock Production Systems.*"[46] After consulting these sources, a comprehensive list of mitigation measures with the potential to reduce ammonia emissions from CAFs was developed (see Table III-9).

TABLE III-9
POTENTIAL AMMONIA CONTROL MEASURES FOR CONFINED ANIMAL FACILITIES (CAFS)

	Measure	Reference	Source
Nutrition and Feed Management			
1	Group and phase feeding; feed additives; feed processing, storage & delivery; dietary formulation changes	Agricultural Air Quality Conservation Measures, Reference Guide for Poultry and Livestock Production Systems	USDA-EPA
2	Reduce protein content; phase feeding; increase grazing time	The Impact of Ammonia Emissions from Agriculture on Biodiversity	*Rand Europe and the Royal Society, Guthrie*, S., et al. 2018. doi: 10.7249/RR2695
3	Phase-feed crude protein (beef steers)	Effects of Phase-Feeding of Crude Protein on Performance, Carcass Characteristics, Serum Urea Nitrogen Concentrations, and Manure Nitrogen of Finishing Beef Steers	*J. of Animal Science*, Cole, N. A., et al. 2006. doi: 10.2527/jas.2006-150
4	Reduce crude protein (beef cattle)	Reducing Crude Protein in Beef Cattle Diet Reduces Ammonia Emissions from Artificial Feedyard Surfaces	*J. of Environmental Quality,* Todd, R. W., et al. 2006. doi: 10.2134/jeq2005.0045
5	Reduce dietary crude protein (beef cattle)	Influence of Dietary Crude Protein Concentration and Source on Potential Ammonia Emissions from Beef Cattle Manure	*J. of Animal Science*, Cole, N.A., et al. 2005. doi: 10.2527/2005.833722x
6	Reduce dietary crude protein (pigs)	The Influence of Diet Crude Protein Level on Odour and Ammonia Emissions from Finishing Pig Houses	*Bioresource Technology*, Hayes, E.T. 2004. doi: 10.1016/s0960-8524(03)00184-6

[45] 87 FR 60494
[46] https://www.epa.gov/sites/default/files/2017-01/documents/web_placeholder.pdf

	Measure	Reference	Source
7	Reduce dietary protein	Reducing Dietary Protein Decreased the Ammonia Emitting Potential of Manure from Commercial Dairy Farms	*The Professional Scientist*, Hristov, A. N., 2015. doi: 10.15232/pas.2014-01360
Animal Confinement/Housing			
8	Litter amendments and manure additives; oil spraying/sprinkling; wet scrubbers; windbreaks and shelterbreaks	Agricultural Air Quality Conservation Measures, Reference Guide for Poultry and Livestock Production Systems	USDA-EPA
9	Scrub air; wash floors; increase outdoor grazing; floor design (slats, grooves, v-shaped gutters, sloping floors); acclimatize barn (insulation, auto-controlled natural ventilation); cool manure surface, acidify slurry / shift chem. balance from ammonia to ammonium; straw bedding for cattle housing	The Impact of Ammonia Emissions from Agriculture on Biodiversity	*Rand Europe and the Royal Society,* Guthrie, S., et al. 2018. doi.10.7249/RR2695
10	Clean lanes at dairies	Ammonia Fluxes from Animal Housing at a California Free Stall Dairy	California State University, Fresno Center for Irrigation Technology and Plant Science Depts., Beene, M. et al. 2005.
11	Clean lanes at dairies	Assessment of Reactive Organic Gases and Amines from a Northern California Dairy Using the USEPA Surface Emissions Isolation Flux Chamber	14th USEPA Annual Emissions Inventory Conference, Las Vegas, Schmidt, C. E., et al. 2005.
12	Corrals: constantly manage corrals	Dairy Air Emissions Report: Summary of Dairy Emission Estimation Procedures	Card, T. and Schmidt, C. 2006. Final Report to California Air Resource Board.
13	Corrals: frequency of corral manure management	2008 Dairy Emissions Study: Summary of Dairy Emission Factors and Emission Estimation Procedures	Schmidt, C. Card, T. 2009. August 2009. Final Report to San Joaquin Valley Air Pollution Control District.
14	Enclosed barns with biofiltration systems	Clearing the Air: Mitigating the Impact of Dairies on Fresno County's Air Quality and Public Health	California Institute for Rural Studies, Kresge. 2007.

	Measure	Reference	Source
15	Scrape /flush freestall lanes	Reduction of ammonia emissions from dairy cattle cubicle houses via improved management- or design-based strategies: A modeling approach	*Science of the Total Environment*, Mendes, L.B., et al. 2017. doi: 10.1016/j.scitotenv.2016.09.079
16	Separate urine/manure with 3 percent floor slope	Ammonia Emission from a Double-Sloped Solid Floor in a Cubicle House for Dairy Cows	*J. of Agricultural Engineering Research*, Braam, C.R., 1997. doi: 10.1006/jaer.1997.0215
Manure Management/Storage			
17	Manure storage covers; solid-liquid separation; oxygenation of liquid manure lagoons; composting; anaerobic digester	Agricultural Air Quality Conservation Measures, Reference Guide for Poultry and Livestock Production Systems	USDA-EPA
18	Solid cover; floating cover; natural crust; floating crust; replace lagoons with deep tanks; storage bags	The Impact of Ammonia Emissions from Agriculture on Biodiversity	*Rand Europe and the Royal Society, Guthrie*, S., et al. 2018. doi: 10.7249/RR2695
19	Anaerobic digesters	Clearing the Air: Mitigating the Impact of Dairies on Fresno County's Air Quality and Public Health	California Institute for Rural Studies, Kresge. 2007.
20	Cover manure piles	Emissions of Ammonia, Nitrous Oxide and Methane from Cattle Manure Heaps: Effect of Compaction and Covering	*Atmospheric Environment*, Chackdick, D.R. 2005. doi: 10.1016/j.atmosenv.2004.10.012
21	Farm lagoon effects on environmental health; sprayfields effect on environmental health	Cesspools of Shame: How Factory Farm Lagoons and Sprayfields Threaten Environmental and Public Health	Marks, R. Natural Resources Defense Council and the Clean Water Network, 2001.
Land Application			
22	Timing of land application; injection; incorporation; banding	Agricultural Air Quality Conservation Measures, Reference Guide for Poultry and Livestock Production Systems	USDA-EPA
23	Incorporate manure into soil (within minute, 4 hours, or 24 hours); lower slurry pH to 6 or	The Impact of Ammonia Emissions from Agriculture on Biodiversity	*Rand Europe and the Royal Society, Guthrie*, S., et al. 2018. doi: 10.7249/RR2695

	Measure	Reference	Source
	less; band spreading; trailing hose; trailing shoe; injector		
24	Dilute liquid manure applied to land	Managing Dairy Manure in the Central Valley of California	University of California Division of Agriculture and Natural Resources Committee of Experts on Dairy Manure Management, 2005.
25	Incorporate manure into soil	Ammonia Volatilization from Manure Application	Atia, A. Agri-Facts. Agriculture Stewardship Division Alberta Agriculture and Food. 2008.

Brief descriptions of the measures listed in Table 4 that reduce NH3 emissions from livestock waste are provided below. Measures previously considered as part of the 2016 AQMP are also discussed.

Dietary Manipulation/Feed Additives

Dietary formulation changes involve changes in feed ingredients or ration formulations to provide essential nutrients to meet animal requirements while minimizing excess amounts of nutrients. Dietary manipulation such as lowering the protein content and including high-fiber ingredients is a potential method to decrease ammonia emissions from monogastric animals' and ruminants' manure. However, lowering the dietary protein content of dairy cattle negatively impacts milk production according to UC Davis Extension Specialist Dr. Peter Robinson.[47]

Group and Phase Feeding

Group and phase feeding practices involve separating animals by age or production state (phase), and/or by sex to provide diets that more closely match the different nutritional needs of each phase and sex to avoid providing excess nutrients in diets.

Litter Amendments and Manure Additives

Litter amendments and manure additives address the generation of emissions by changing manure properties to prevent emissions from forming. Commonly used litter amendments and manure additive categories include: (1) chemicals (i.e., acidifiers); (2) adsorbents; and (3) biological compounds (i.e., microbes or enzymes).

[47] A list of selected scientific publications by Peter Robinson, PhD is available on the UC Davis website at: https://animalscience.ucdavis.edu/people/faculty/peter-robinson/Articles/Scientific-Publications

Oil Spray/Sprinkling

Vegetable oil (crude canola, purified canola, flax, corn, sunflower or soybean oils) is sprayed into the air in animal production areas, and particles that stick to the droplets settle onto the building surfaces. While this practice originated as a measure to reduce PM emissions, smaller reductions of hydrogen sulfide and NH3 emissions have also been observed with the use of oil sprinkling.

Biofilters

A biofilter is an air filtration and odor mitigation system that channels building exhaust through a mixture of organic materials (e.g., compost, wood chips) that support microbial growth. An air distribution system distributes the pollutant-laden air from the building exhaust to the biofilter bed (media) where microorganisms living on the biofilter media break down the pollutant gases into carbon dioxide (CO2), water and salts.

Wet scrubbers

Wet scrubbers can be used to reduce emissions from mechanically ventilated animal production houses. The wet scrubbers used in animal production operations are usually custom designed and use either water droplets or chemical (e.g., acidic) droplets to capture pollutants.

Windbreaks and Shelterbreaks

Using upwind windbreaks or shelterbreaks can reduce exchange of fresh air over animal housing and manure storages, which can reduce the potential for emissions from these sources.

Manure Storage Covers

Manure is often stored prior to land application – either as a liquid or slurry in open earthen basins or tanks or as a solid in stacks or piles. Emissions are generated due to biological activity within the decomposing manure. Air exchange caused by wind passing over these storages is a source of emissions as pollutants are drawn by diffusion from areas of higher concentration (manure storages) to areas of lower concentration (fresh air). Additionally, the direct transport of pollutants from these storages by the wind is another source of emissions. The use of a cover allows producers to significantly limit the release and transport of these emissions.

Solid-Liquid Separation

The decomposition of manure solids during the anaerobic storage of liquid or slurry manures lead to increased emissions. For manure streams handled as a slurry, separation of the solid and liquid portions prior to storage, additional treatment and/or land application may reduce emissions.

Oxygenation of Liquid Manure Lagoons

Lagoons that treat and store manure as a liquid or slurry can be designed as either anaerobic or aerobic lagoons. As the manure in the lagoon decomposes anaerobically, it releases emissions. If sufficient oxygen is provided to the system, aerobic bacteria can break down these organic compounds into simpler forms.

Composting

Composting is a biological method of decomposition of manure in a controlled manner that involves maintaining specific carbon to nitrogen (C:N) ratios, moisture levels, temperature and aeration levels. Similar to the benefits of aeration for liquid or slurry manure, properly managed compost operations can reduce ammonia emissions from solid manure. Finished compost is a stable product that can serve as a valuable soil amendment.

Anaerobic Digester

Anaerobic digestion (AD) is a process in which microorganisms break down manure, but unlike composting, AD occurs in the absence of oxygen, or anaerobically. While AD occurs naturally in traditional manure storage and treatment lagoons under anaerobic conditions, it is usually incomplete and inefficient. By using a higher loading rate, incorporating mixing, heating the process and maintaining a consistent volume, anaerobic digestion will maximize reductions.

Timing of Land Application

Timing of land management practices such as application according to agronomic recommendation and application under cool and calm weather conditions can reduce emissions. Agronomic application is the application of nutrients to meet crop needs, including the timing of those nutrient needs. By matching crop needs to available nutrients, over-application of nitrogen can be reduced, which will minimize subsequent NH3 and N2O emissions.

Additionally, temperature, humidity, wind speed and precipitation influence the rate of NH3, PM and odor losses. The application of manure during cool, calm weather with higher humidity will decrease the amount of NH3 volatilized from the manure. Applying nutrients in the spring prior to planting when crops are ready to utilize the nitrogen can reduce NH3 emissions compared to applying in the fall. Light precipitation events following application can also decrease NH3 volatilization by binding NH3 to soil clays.

Injection

Manure from animal production facilities is usually applied to fertilize crops on land. Liquid and/or slurry manure (e.g., manure from swine, dairy production) is injected beneath the soil surface at a minimum depth of four inches by a tractor-pulled tank wagon or dragline injection system to conserve nitrogen.

Incorporation

Incorporation involves mixing manure or litter with surface soil at a minimum depth of four inches such that at least 80 percent of applied manure is covered with soil. Broadcasting manure, either solid or liquid, without incorporation results in the highest emissions. Incorporation may be accomplished by using standard agricultural practices (e.g., tandem-disk tillage) or other equivalent practices that provide 80 percent soil coverage.

Banding

Banding of manure involves the application of liquid manure in narrow bands either directly from a spreader hose or through a sliding shoe that rides along the soil surface. Banding allows relatively low-pressure manure application with less soil disturbance than incorporation. Reduced volatilization of gases from the low pressure application results in reductions of NH3 emissions.

Potential Emission Reduction

Table III-10
2030 Baseline Emissions from Livestock Waste

Facility type	NH3 Emissions (tpd)
Dairy Cattle	5.08
Range Cattle	0.13
Poultry - Layers	0.28
Swine	0.02
Sheep	0.08
Horses	0.51
Goats and Others	0.05
Total	**6.13**

As shown in Table III-10, the total inventory for this source category is 6.13 tpd of NH3 in 2030, yet dairy cattle are responsible for over 80 percent of those emissions. Lowering Rule 223 applicability thresholds results in an estimated 5 percent NH3 emission reduction (from additional 46,000 cows regulated relative to a threshold reduction from 1,000 cows to 500 and 650,000 chickens to 400,000). Thus, the estimated reduction from lowering the thresholds in Rule 223 for dairy cattle and poultry layers is 0.27 tpd.

Emission reductions are estimated for the incorporation of solid cattle manure within 24 hours and acidifying amendments for poultry litter. Assuming that 2.8 percent of dairy cattle NH3 emissions are from solid manure land application and high-disturbance land incorporation within 24 hours reduces NH3 emissions by 75 percent, the NH3 reductions are estimated to be 0.11 tpd.[48] Regarding acidifying

[48] Ammonia: Supplemental Information for EPA in Support of 15 µg/m^3 Annual PM2.5 Standard, CARB. March 2023

amendments, a recent study found that an application rate of 98 kg of aluminum sulfate per 100 square meters incorporated into poultry litter reduced overall ammonia emissions from poultry broilers by 35 percent.[49] Assuming the same control efficiency for poultry layers results in NH3 emission reductions of 0.098 tpd.

Technological Feasibility

Lowering Rule 223 applicability thresholds is technologically feasible. The remainder of the feasibility assessment concerns the mitigation measures listed in Table III-9.

It is not feasible for all CAFs to implement the same mitigation measures due to various factors, such as infrastructure, conditional use permits, water quality regulations, production contracts, and other limitations. Furthermore, CAFs in the Basin face unique challenges including hot, dry summers, drought conditions, and strict water regulations, which render some measures infeasible. The mitigation measures included in Rule 223 provide the owners and operators of CAFs much needed flexibility to choose the mitigation measures that make the best environmental and economic sense for their facility, while maximizing the amount of emission reductions. Nonetheless, the mitigation measures listed in Table III-9 provide potential opportunities to further reduce emissions.

CARB recently conducted an exhaustive feasibility analysis of the mitigation measures listed in Table III-9.[50] This feasibility analysis was relied upon as a screening tool to identify which of the mitigation measures deserve increased scrutiny in South Coast AQMD's analysis. CARB identified the following measures with theoretical potential to further reduce emissions from dairies and poultry operations:

1. Incorporation of solid cattle manure within 24 hours

   Land incorporation reduces NH3 emissions by decreasing the exposed surface area of manure. Rule 223 includes land incorporation of all manure within 72 hours of removal as a Class One Mitigation Measure. It is technologically feasible to reduce the window from 72 hours to 24 hours while allowing exceptions (e.g., for extreme weather). High-disturbance land incorporation, which requires chisel plowing followed by secondary tillage with a disk harrow or field cultivator, is expected to achieve the greatest reductions.

2. Acidifying amendments for poultry litter

   Ammonia is a weak base and reducing the pH of litter binds ammonia and reduces its volatilization. Aluminum sulfate, also known as alum, is a common compound used to treat poultry litter to reduce ammonia emissions and bind phosphorous to prevent runoff. It is technologically feasible to require the application of alum to poultry litter.

[49] Anderson, K.; Moore, P.A., Jr.; Martin, J.; Ashworth, A.J. (2020) Effect of a New Manure Amendment on Ammonia Emissions from Poultry Litter. *Atmosphere*, *11*, 257. https://doi.org/10.3390/atmos11030257

[50] Ammonia: Supplemental Information for EPA in Support of 15 µg/m^3 Annual PM2.5 Standard, CARB. March 2023

Economic Feasibility

The cost-effectiveness for high-disturbance incorporation of solid manure is estimated to range from $26,400/ton to $256,840/ton depending on whether only additional labor is required or a custom farm service must be used.[51]

The application rate of alum on a per bird basis is 0.074 kg/bird[52] and the South Coast Air Basin NH3 emission factor for poultry layers is 0.19 lbs/head-year. Assuming a 35 percent reduction in NH3 emissions, the reduction is equivalent to 0.067 lbs/head-year. The application cost is estimated as $0.63/head.[53] Alum must be applied prior to placing each flock and it is assumed that there is one poultry layers flock per year. Therefore, the cost-effectiveness is calculated as follows:

$0.63/head ÷ 0.067 lbs/head-year x 2,000 lb/ton = $18,806/ton

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure
BACM/BACT	0.48 tpd of NH3 by 2030	No	No	No
Additional feasible measure		No	No	No
MSM		Feasible	Feasible	Yes - partial

For the purposes of satisfying MSM, South Coast AQMD commits to lower the applicability threshold in Rule 223. Independent of MSM, the feasibility of the mitigation measures will be further explored during rulemaking. Considering South Coast AQMD's extensive and thorough rulemaking public process, this measure cannot be feasibly implemented within 4 years of reclassification, nor can it be implemented by 2025, the statutory "serious" area attainment year. However, considering the 5 year extension of the attainment year pursuant to CAA section 188(e), this measure can be feasibly implemented in whole or in part by 2030.

[51] Ibid
[52] Ibid
[53] Ibid

Potential Control Measure 5 - Further Emission Reductions from Agricultural, Prescribed, and Training Burning

Target Pollutant

PM2.5

Synopsis

This control measure would seek further emission reductions from certain categories of open burning including agricultural and prescribed (e.g., forestry service) burning activities, as well as training burns. Agricultural burning involves the collection and combustion of vegetation produced from the growing and harvesting of crops. Prescribed burning is the planned burning of vegetation, usually conducted by a fire agency or the forest service to mitigate wildfire impacts or control plant disease and pests. Training burns are conducted by fire departments to practice suppressing fires. Rule 444 includes a Basin-wide no-burn provision when forecasted AQI is expected to exceed 150 in any area of the Basin. If the Basin-maximum forecasted AQI does not exceed 150, prescribed burning is prohibited in areas with AQI values exceeding 100 but agricultural burning is still prohibited for the entire Basin. While this provision controls episodic emissions on days with the worst air quality, it does not produce emission reductions on an annual basis since burning activities are shifted to other days.

PM2.5 emission reductions from agricultural burning can be achieved through incentivizing the use of alternatives (e.g., chipping/grinding or composting), with priority for eliminating burn projects located near sensitive receptors. The alternatives will produce emissions directly (e.g., chipping and grinding) or indirectly (e.g., transport of material to composting facilities) although they are still anticipated to result in a net emission reduction.

Potential Emission Reduction

The 2030 baseline emission inventory is 0.27 tpd of PM2.5 for prescribed and training burns.

The 2030 baseline emission inventory is 0.0086 tpd of PM2.5 for agricultural burning.

Technological Feasibility

Burning alternatives such as chipping/grinding or composting are widely available for agricultural applications.

The Menu of Control Measures developed by the U.S. EPA also recommends the inclusion of a provision to require higher fuel moistures during prescribed burns. For forestry burning, this is intended to decrease

emissions by decreasing the amount of fuel burned and can be accomplished by either removing lighter and drier fuels or burning in early spring when moisture levels are naturally higher. There are renewed efforts to drastically increase the number of acres treated by prescribed fire in order to reduce the air quality impacts of increasingly intense wildfires caused by years of drought due to climate change and past forest management practices that have allowed the accumulation of the understory in forests throughout the west. Forest management, whether through chipping and griding or prescribed fire, reduces overall emissions by reducing the intensity and available fuel of wildfires occurring on recently treated lands.

The distinct wet and dry seasons in the South Coast Air Basin along with poor summertime air quality that may restrict prescribed fire for nearly half of a year in some locations make finding suitable conditions for prescribed fire extremely challenging for fire agencies. Further restricting the number of days available for prescribed fire by setting fuel moisture requirements is inconsistent with the goal of increasing the number of acres treated by prescribed fire and may result in higher intensity wildfires, increased threats to life and property, and increased emissions that occur from fires that burn on untreated lands. Similarly, restricting training burns runs counter to the goal of wildfire containment as experienced firefighting crews need to rapidly mobilize in the event of wildfires. Further restricting their ability to train will hamper those efforts. Therefore, this provision in the Menu of Control Measures is not technologically feasible for prescribed and training burns.

Economic Feasibility

The cost-effectiveness of this measure as it applies to agriculture has not been estimated. However, costs to implement burning alternatives would be expected to be higher due to equipment and labor costs. Agricultural burning is much more prevalent in the SJVAPCD (36 percent of statewide emissions compared to <1 percent in the South Coast Air Basin).[54] The extent of burning is reported to CARB on an annual basis based on the acreage of crops cleared to produce a burn pile. In 2022, there were only 10.1 acres cleared for agricultural burning in the Basin.[55] By comparison, there were 33,451 acres cleared in 2022 for agricultural burning in the SJVAPCD.[56] Due to the high incremental cost associated with chipping and grinding, SJVAPCD provides incentives ranging from $300/acre to $1,300/acre depending on the crop and whether soil incorporation is included.[57] The extremely limited extent of agricultural burning combined with the high cost of alternatives suggest that this measure is economically infeasible and has no practical air quality benefit. Nevertheless, South Coast AQMD commits to perform outreach to the entities that perform agricultural burns to raise awareness of alternatives such as chipping and grinding.

[54] https://ww2.arb.ca.gov/sites/default/files/2021-02/Staff_Recommendations_SJV_Ag_Burn.pdf
[55] South Coast AQMD Open Burn Program Log Book
[56] Email from Leland Villalvazo, SJVAPCD, September 11, 2023
[57] https://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2021/August/final/10.pdf

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure
BACM/BACT	TBD	No	No	No
Additional feasible measure		No	No	No
MSM		No	No	No

Control measure BCM-17 involves a wildfire prevention program that seeks to incentivize hand-thinning, mechanical thinning, and chipping and grinding to mitigate excess fuels in urban-wild-interface areas of the San Bernardino National Forest. The scope of the measure is limited to a pilot project to further assess the effectiveness of incentive programs.

Potential Control Measure 6 - Further Emission Reductions from Commercial Cooking - Charbroilers

Target Pollutant

PM2.5

Synopsis

Rule 1138 regulates VOC and PM emissions from restaurant operations by requiring the installation of flameless catalytic oxidizers, or equivalent control devices, to chain-driven charbroilers. The Rule covers chain-driven charbroilers cooking 875 pounds of meat or more per week, applicable mostly to large restaurant chains. Although under-fired charbroilers are another source of emissions from restaurant operations, no cost-effective control technology was identified for this type of equipment at the time of rule adoption. In the decade following adoption of Rule 1138, staff reported to the Governing Board regarding under-fired charbroiler control technology assessments, but amending the rule was determined to be infeasible. In 2008, staff reinitiated rule development for charbroilers and held a series of working group meetings and a public workshop. Rule amendment was again concluded to be infeasible due to the lack of affordable control technologies.

Staff has conducted an analysis of the state of PM control technology as well as potentially more stringent requirements in some of the other air districts. SJVAPCD Rule 4692 reduces PM emissions by requiring catalytic oxidizers for chain-driven charbroilers cooking 400 pounds of meat or more per week. This threshold is more stringent than that in Rule 1138 which applies to chain-driven charbroilers cooking 875 pounds of meat or more per week. Staff commits to evaluate the feasibility of lowering the applicability threshold for chain-driven charbroilers in Rule 1138.

Finally, SJVAPCD amended Rule 4692 to require registration and reporting for under-fired charbroilers. SJVAPCD Rule 4692 requires a one-time report for all commercial under-fired charbroilers submitted. Information required include typical details (name, location of establishment), number and size of cooking

surface of all underfired charbroilers, type of fuel, type and pounds of meat cooked on a weekly basis, operating hours of cooking operation, flow rate (in cubic feet per minute, or CFM) of hood or exhaust system, manufacturer, and model of any installed pollution control devices (particulates, kitchen smoke, and/or odors). See below for the information that must be provided:[58]

- Name and location of the commercial cooking operation;
- Number and size, in cooking surface square feet, of all underfired charbroilers at the commercial cooking operation;
- Type of fuel used to heat the underfired charbroiler(s);
- Type and quantity, in pounds, of meat cooked on the underfired charbroiler(s) on a weekly basis for the previous 12-month period;
- Daily operating hours of the commercial cooking operation;
- Flowrate (cubic feet per minute) of hood or exhaust system(s) serving each underfired charbroiler; and
- The manufacturer and model of any installed pollution control devices designed for the reduction of particulates, kitchen smoke and/or odor.

South Coast AQMD Rule 222 also requires that all charbroilers in the South Coast jurisdiction be registered and provide sufficient data as determined by South Coast AQMD to determine compliance. Registrations must be renewed annually and refiled if there is a change of ownership/name/location.

Staff does not interpret registration and reporting requirements as an applicable MSM. This is because these requirements are purely administrative and do not achieve emission reductions. Nevertheless, staff commits to consider a registration program to improve the accuracy of the emissions inventory for charbroilers.

Potential Emission Reduction

The 2030 baseline inventory is 9.13 tpd of PM2.5 for this source category.

Potential emission reductions for lowering the rule applicability threshold for chain-driven charbroilers cannot be determined due to a lack of updated data with meat cooked throughput.

Technological Feasibility

It is technologically feasible to lower the rule applicability threshold for chain-driven charbroilers.

[58] SJVAPCD Rule 4692 Commercial Charbroiling (Adopted March 21, 2002; Amended September 17, 2009; Amended June 21, 2018)

Economic Feasibility

While the number of chain-driven charbroilers that would be affected by lowering the threshold is unknown, SJVAPCD Rule 4692 already enforces the lower threshold so it is reasonable to conclude that this control measure is economically feasible.

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure
BACM/BACT	TBD	No	No	No
Additional feasible measure		No	No	No
MSM		Yes	Yes	Yes

This PCM has been incorporated into the control strategy as BCM-12. Considering South Coast AQMD's extensive and thorough rulemaking public process, BCM-12 cannot be feasibly implemented within 4 years of reclassification, nor can it be implemented by 2025, the statutory "serious" area attainment year. However, considering the 5 year extension of the attainment year pursuant to CAA section 188(e), BCM-12 can be feasibly implemented in whole or in part by 2030.

Potential Control Measure 7 - Further Emission Reductions from Paved Road Dust

Target Pollutant

PM2.5

Synopsis

This measure would seek further PM2.5 emission reductions from fugitive dust sources, primarily paved roads. While fugitive dust emissions from agriculture and construction are primarily in the coarse size fraction (PM10-2.5), entrained paved road dust is a major direct PM2.5 source due to the large number of roadways and high traffic volumes in the region. South Coast AQMD Rule 1186 - PM10 Emissions from Paved and Unpaved Roads, and Livestock Operations establishes requirements to prevent material from being deposited on roadways and requires local jurisdictions to procure certified street sweeping equipment.[59]

Most cities in the Basin have routine street sweeping frequencies of once or twice per week due to stormwater regulations. Specifically, existing National Pollution Discharge Elimination System (NPDES) permits required under the Clean Water Act currently specify street sweeping frequencies as part of a

[59] http://www.aqmd.gov/docs/default-source/rule-book/support-documents/rule-1186/certified-street-sweepers-equipment-list.pdf?sfvrsn=2

comprehensive program to reduce debris from entering storm drains.[60] Thus, regulations are currently in place to require street sweeping at specified frequencies with South Coast AQMD-certified equipment. Accordingly, the BACM analysis included in the 2016 AQMP concluded the South Coast AQMD's existing rules and regulations are equivalent to, or more stringent than other districts' rules and regulations and met the BACM requirements. The 2016 AQMP did, however, include Control Measure BCM-03 (Further Emission Reductions from Paved Road Dust Sources) that proposed a review of current South Coast AQMD Rule requirements to determine if additional emission reductions could be achieved. Therefore, this PM2.5 Plan includes control measure BCM-14 that proposes an additional evaluation of paved road dust emissions.

Potential controls may include establishing increased sweeping frequencies for freeways and highways, establishing new test protocols to measure both PM2.5 and PM10 road dust emissions from sweepers, and requiring use of the most efficient sweepers with the lowest dust entrainment rates.

Potential Emission Reduction

The 2030 baseline inventory is 9.11 tpd of PM2.5 for this source category.
Potential emission reduction from this control measure is TBD.

Technological Feasibility

Studies that examine the effect of street sweeping on PM levels are scarce. A recent study in Chiayi City, Taiwan concluded that street sweeping combined with street washing is effective at reducing ultrafine particle concentrations.[61] Another study conducted in Krakow, Poland found that street sweeping followed by intensive washing reduced road dust PM2.5 by 20-33 percent.[62] However, due to the tendency for the South Coast Air Basin to experience extreme drought, street washing is infeasible. Additionally, NPDES regulations prohibit street washing. Thus, these studies are not applicable to our region. The only studies identified as potentially applicable to our region found that closed system regenerative air sweepers are more efficient and less polluting compared to vacuum and mechanical brush sweepers.[63,64]

Mandating increased street sweeping frequencies has unknown impacts on PM2.5 levels. Therefore, a pilot project along with a comprehensive atmospheric measurement campaign would be needed to assess the effectiveness of street sweeping frequency and technology as a method to reduce ambient PM2.5.

[60] City of Fullerton, 2015. Contact with Ty Richter, Street Supervisor, City of Fullerton, September 2015.
[61] Do the Street Sweeping and Washing Work for Reducing the Near-ground Levels of Fine Particulate Matter and Related Pollutants? https://doi.org/10.4209/aaqr.220338
[62] Impact of Street Sweeping and Washing on the PM10 and PM2.5 Concentrations in Cracow (Poland) https://ros.edu.pl/index.php?view=article&id=740:043-ros-v21-r2019&catid=51&lang=pl
[63] https://www.tymco.com/wp-content/themes/va/pdf/Cleanroads-APWAReporter-092007.pdf
[64] ECORP Consulting, Inc. Strategic Street Sweeping Study prepared for Coachella Valley Association of Governments. November 2022.

New test protocols that evaluate the PM2.5 performance of sweepers, such as those in Toronto and Europe,[65,66] may be needed as well.

Economic Feasibility

Street sweeping costs vary greatly based on the number of miles and frequencies and whether the work is conducted with in-house or contracted resources. A survey of several large cities conducted in 2018 determined that the median annual cost of street sweeping was $52.31 per curb mile.[67] The cost of mandating increased street sweeping frequencies can be substantial considering that the City of Los Angeles alone has over 230,000 curb miles to maintain. A pilot project would provide further insight into the cost-effectiveness of this measure.

[65] https://www.toronto.ca/wp-content/uploads/2018/02/94cd-CRCA_PM-Efficiency-Protocol-May2016.pdf
[66] https://www.eu-nited.net/eunited+aisbl/municipal-equipment/sweepers-/index.html
[67] https://sfbos.org/sites/default/files/BLA_Report_Street_Cleaning_Cost_Survey_062518.pdf

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure
BACM/BACT	TBD	No	No	No
Additional feasible measure		No	No	No
MSM		Yes	No	No

Other Considerations

South Coast AQMD has determined that further evaluation is required prior to fully implementing this control measure. Control measure BCM-14 proposes a pilot project to assess the effectiveness of increased street sweeping using regenerative air sweepers.

Potential Control Measure 8 - Further Emission Reductions from Wood-Burning Fireplaces and Wood Stoves

Target Pollutant

PM2.5

Synopsis

Rule 445 currently implements robust controls designed to reduce PM2.5 emissions from wood-burning devices. During wood-burning season, PM2.5 mandatory burning curtailment (No-Burn days) may be declared by the Executive Officer based on PM2.5 air quality forecast. However, there is an exemption for low-income households defined as "any household that receives financial assistance through reduced electric or gas bills from an electric or natural gas utility based on household income levels." There are two financial assistance programs in California: Family Electric Rate Assistance (FERA) and California Alternate Rates for Energy (CARE). Staff estimated that 15-20 percent of single-family households qualify for CARE over an inland range covering Los Angeles and Orange Counties.[68] This is potentially a lower bound estimate of the households qualifying for the low-income exemption in Rule 445 since the qualified income thresholds are slightly higher for FERA than CARE.

[68] Net Emissions Analysis Tool (NEAT) documentation. http://www.aqmd.gov/home/air-quality/clean-air-plans/air-quality-mgt-plan/neat-main

Potential Emission Reduction

The 2030 baseline inventory is 4.82 tpd of PM2.5 for all wood-burning devices.

Potential emission reductions have not been estimated.

Technological Feasibility

It is technologically feasible to remove the low-income exemption for households with an alternative source of heat.

Economic Feasibility

Removing the low-income exemption from the mandatory curtailment would result in indeterminate cost increases to the impacted community. However, this control measure does not propose to modify existing curtailment exemptions provided to sole source of heat households or those not serviced by natural gas. This potential control measure would effectively only apply to ambiance burning in low-income households. Therefore, it is economically feasible.

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure
BACM/BACT	TBD	No	No	No
Additional feasible measure		No	No	No
MSM		Feasible	Feasible	Yes

Considering South Coast AQMD's extensive and thorough rulemaking public process, this measure cannot be feasibly implemented within 4 years of reclassification, nor can it be implemented by 2025, the statutory "serious" area attainment year. However, considering the 5 year extension of the attainment year pursuant to CAA section 188(e), this measure can be feasibly implemented by 2030.

Potential Control Measure 9 - Emission Reductions from Organic Waste Composting

Target Pollutant

NH3

Synopsis

This proposed control measure would seek emission reductions of NH3 from composting of organic waste (i.e., greenwaste, foodwaste, and agricultural waste streams). Control approaches include pollution

prevention technology, anaerobic digestion in lieu of composting, and restrictions for direct application of uncomposted, chipped or ground greenwaste (e.g., compostable mulch) to public lands.

California has passed legislation to divert organic waste from landfills including AB 1826 (Mandatory Commercial Organics Recycling; Chesbro, Chapter 727, Statutes of 2014) and SB 1383 (Short-Lived Climate Pollutants; Lara, Chapter 395, Statues of 2016). SB 1383 sets statewide targets to reduce disposal of organic waste in landfills by 75 percent from 2014 levels and to save at least 20 percent of currently disposed surplus food for consumption by 2025.[69] SB 1383 organic waste mandates are implemented by local jurisdictions with oversight from California's Department of Resources Recycling and Recovery (CalRecycle). CalRecycle conducted a formal rulemaking process through collaboration with other stakeholders that resulted in regulations for organic waste management programs. Organic waste includes a broad range of waste categories such as food, green material, landscape and pruning waste, organic textiles and carpets, lumber, wood, paper products, printing and writing paper, manure, biosolids, digestate, and sludges that will be diverted from landfills and taken to the appropriate organic waste recovery facilities. Local jurisdictions must have their organic waste management programs in effect by January 1, 2022 and are required to take enforcement against noncompliance starting January 1, 2024.[70]

According to Table 2-3 of CalRecycle's Final Environmental Impact Report, 46 new or expanded compost facilities and 24 new or expanded anaerobic digester facilities would be required in the South Coast Air Basin by 2030 to process the diverted waste.[71] While overall Short-Lived Climate Pollutant emissions are expected to decline, emissions from processing of organic waste via composting and anaerobic digestion are expected to grow. Organic waste may contain pathogen infections and is known to increase NH3 emissions, if not composted properly. Therefore, this control measure proposes minimum composting standards to eliminate pathogens and minimize NH3 emissions. It also seeks to evaluate emerging technologies to further control emissions from organic waste.

Potential Emission Reduction

The 2030 baseline inventory is 0.67 tpd of NH3 for this source category. Emission reductions were not estimated.

Technological Feasibility

Pollution Prevention Technology

Rule 1133.3 requires 80 percent control of VOC and NH3 emissions for a greenwaste composting pile containing greater than 10 percent foodwaste. Emerging pollution prevention technologies are able to process these waste materials without the microbial decomposition of organic materials, concurrently killing pathogens and thereby minimizing VOC and NH3 generation from the process. As an example,

[69] https://calrecycle.ca.gov/organics/slcp/
[70] An Overview of SB 1383's Organic Waste Reduction Requirements. https://www2.calrecycle.ca.gov/Docs/Web/115800
[71] CalRecycle Final Environmental Impact Report. https://www2.calrecycle.ca.gov/Docs/Web/119973

ReGreen International Solutions, Inc. (ReGreen) systems can handle and process organic material and municipal solid waste into a stable byproduct such as animal feed, soil amendments/fertilizers, or clean-burning energy pellets. Another example is Waste Management (WM's) proprietary Centralized Organic Recycling equipment (CORe®) process that recycles commercial and institutional pre- and post-consumer foodwaste into an Engineered BioSlurry (EBS®) that is added to wastewater treatment plant anaerobic digesters to increase the production of biogas.

Anaerobic Digestion

Anaerobic digestion is a process through which bacteria digest organic matter such as animal manure, wastewater biosolids (e.g., municipal sewage sludge), and foodwaste in the absence of oxygen. Anaerobic digestion for biogas takes place in a sealed vessel called a reactor, which is designed and constructed in various shapes and sizes specific to the site and feedstock conditions. These reactors contain complex microbial communities that digest the waste and produce resultant biogas and other useful coproducts (i.e., solid and liquid portions of the digestate). Multiple organic materials can be combined in one digester. Co-digested materials include manure, foodwaste (pre- and post-consumer), crop residues, and fats, oils and greases (FOG) from restaurant grease traps, and many other sources. Co-digestion can increase biogas production from low-yielding or difficult-to-digest organic waste. There is one co-digestion facility operating in Los Angeles County that receives foodwaste and sewage sludge to produce biogas for Compressed Natural Gas (CNG) transportation fuel and electricity.[72] There are also four standalone anaerobic digestion facilities operating in the South Coast AQMD jurisdiction, which accept and process foodwaste and other organic wastes.[73]

Composting of Chipped Greenwaste Used for Land Application

Shredded curbside and non-curbside greenwaste, if not composted properly, may increase NH3 and VOC emissions or pathogen infections when used as ground cover. Emissions can be reduced by having those materials go through the active phase of composting for at least 15 days. Approximately 85 percent of NH3 emissions occur during the first 15 days of the 22-day active phase composting period required by Rule 1133.3.[74,75] In addition, California Code of Regulations, Title 14, Section 17868.3 requires a pathogen reduction period of 15 days for a windrow composting process. Therefore, NH3 emissions can be reduced from shredded green material applied to public lands (e.g., for erosion control) by imposing restrictions such that chipped and ground greenwaste undergoes a minimum of 15 days of active phase composting before land application. Staff previously estimated NH3 emissions from curbside greenwaste composting feedstock piles at 0.017 lbs/wet ton-day. However, emissions from a layer of land-applied shredded greenwaste materials have not been investigated and thus warrant further research.

[72] https://www.lacsd.org/services/solid-waste-programs/food-waste-recycling
[73] https://www2.calrecycle.ca.gov/Docs/Web/115971. Updated March 2023
[74] Card, T.R. and C.E. Schmidt, 2006. Air emissions source test: Jepson Prairie Organics Compost Facility, Vacaville, CA. Report to NorCal Waste Systems, Inc.
[75] Card, T.R. and C.E. Schmidt, 2009. Northern Recycling Zamora Compost Facility Air Emissions Source Test. Report to Yolo Solano AQMD

Economic Feasibility

The portion of this potential control measure seeking reductions of uncomposted chipped and ground greenwaste is considered economically feasible.

Estimated equipment costs for pollution prevention technology (e.g., ReGreen Technology) are expected to range between $300,000 and $400,000 for a unit that supports up to 0.5 tons/hour of feed. For full scale applications, a 5 tons/hour unit costs up to $3.6 million. The high capital cost is an impediment for widespread adoption and therefore the portion of this potential control measure related to pollution prevention technology is infeasible.

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure
BACM/BACT	TBD	No	No	No
Additional feasible measure		No	No	No
MSM		Feasible	Feasible	Yes - partial

The portion of this potential control measure that is considered MSM has been incorporated into control measure BCM-10. Considering South Coast AQMD's extensive and thorough rulemaking public process, BCM-10 cannot be feasibly implemented within 4 years of reclassification, nor can it be implemented by 2025, the statutory "serious" attainment year. However, considering the 5 year extension of the attainment year pursuant to CAA section 188(e), BCM-10 can be feasibly implemented in whole or in part by 2030.

Potential Control Measure 10 - Emission Reduction of PM from Asphalt Manufacturing

Target Pollutant

PM2.5

Synopsis

This measure is derived from the 2012 version of U.S. EPA's Menu of Control Measures.[76] It estimates a control efficiency of 99 percent in an asphalt manufacturing facility equipped with a fabric filter, or baghouse placed in parallel inside of an enclosure. Rule 1157 - PM10 Emission Reductions from Aggregate

[76] https://www3.epa.gov/ttn/naaqs/pdfs/MenuOfControlMeasures.pdf

and Related Operations targets all aggregate and related operations, but does not require enclosure for all transfer points and activities. However, Rule 1155 regulates all baghouses (including those at asphalt manufacturing facilities), except for those with a filter area less than 100 ft^2 and requires no visible emissions at any time except for start-up and shutdown.

Potential Emission Reduction

The 2030 baseline inventory is 0.18 tpd of PM2.5 for this source category. Emission reductions have not been estimated.

Technological Feasibility

Enclosures and baghouses are generally technologically feasible. The standard (0.01 gr/dscf) for baghouses in asphalt manufacturing facilities was set forth in Rule 1155 and was fully implemented in 2013.

Economic Feasibility

Asphalt manufacturing in the South Coast AQMD is currently regulated under Rule 1157 and Rule 1155, which require the use of filters. Baghouses are not considered economically feasible at the transfer points and activities not covered by Rule 1157 and Rule 1155 based on the low emission inventory and the relative costs for replacement at $27,000 per bag every three to five years.

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure
BACM/BACT	TBD	Feasible	Not Feasible	No
Additional feasible measure		Feasible	Not Feasible	No
MSM		Feasible	Not Feasible	No

Potential Control Measure 11 - Emission Reduction of PM from Wood Pulp and Paper

Target Pollutant

PM2.5

Synopsis

This measure is derived from the 2012 version of U.S. EPA's Menu of Control Measures,[77] which estimated a control efficiency of 95 percent in wood pulp and paper facilities equipped with dry/wet electrostatic precipitators (ESP). Currently, there are five permitted paper and paperboard manufacturing facilities in South Coast AQMD, although all rely on recycled materials. There is no source-specific control measure targeting this source category.

Potential Emission Reduction

The 2030 baseline inventory is 0.039 tpd of PM2.5 for this source category.

Potential emission reduction is not determined. Emission reduction techniques would need to be considered on a site-specific basis.

Technological Feasibility

An ESP is predominantly used to control PM emissions from kraft recovery furnaces used at paper manufacturing facilities that process virgin raw materials. However, manufacturing facilities in South Coast AQMD only process recycled paper and paperboard. For the recycled manufacturing facilities, very little PM is emitted from the pulp dryer, and control techniques for the paper machine vents are considered impractical because of the high moisture content, high volume of the vent exhaust gases, and the minimal pollutant concentrations.[78] As such, ESP control on PM is not technologically feasible for the recycled paper and paperboard manufacturing facilities located within South Coast AQMD.

Economic Feasibility

The control equipment for PM emissions is not expected to be cost-effective for recycled paper and paperboard manufacturing because of very high air flow from the exhaust vents on the roof top of a building where paper machine is situated, and low emission reduction potential.

[77] https://www3.epa.gov/ttn/naaqs/pdfs/MenuOfControlMeasures.pdf
[78] A&WMA, 2000. Air Pollution Engineering Manual, Second Edition, Air & Waste Management Association, page 804

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure
BACM/BACT	N/A	No	No	No
Additional feasible measure		No	No	No
MSM		No	No	No

Staff is not aware of this control measure having been implemented in another nonattainment area or having been achieved in practice in another state for recycled paper manufacturing facilities. This PCM therefore does not meet U.S. EPA's definition of MSM.

Potential Control Measure 12 - Emission Reduction of NOx through Reformulation and Process Modification for Cutback Asphalt

Target Pollutant

NOx

Synopsis

This measure is derived from the 2012 version of U.S. EPA's Menu of Control Measures,[79] which estimated a control efficiency of 100 percent based on the use of reformulated products and the modification of processes associated with cutback asphalt manufacturing to reduce fugitive VOC emissions. In addition, the proposed process would reduce natural gas use by an estimated 20 to 25 percent from reduced processing and transportation temperatures. The reduction in natural gas use results in NOx emission reductions. Cutback asphalt is regulated under Rule 1108 which requires that cutback asphalt contains ≤ 0.5 percent by volume organic compounds at 260°C or lower.

Potential Emission Reduction

Emissions and emission reductions are TBD.

[79] https://www3.epa.gov/ttn/naaqs/pdfs/MenuOfControlMeasures.pdf

Technological Feasibility

Recent studies on warm-mix asphalt (WMA) have shown reductions in smoke and odors, lower emissions, improved workability, better working conditions and better performance.[80] The study findings recommend that use of WMA be encouraged and that water-based WMA technologies should be closely monitored in mix-design and quality control/quality assurance testing to avoid moisture related issues. While WMA use may result in little or no reductions in VOC emissions, the reduced temperatures associated with WMA (approximately 20 percent lower than traditional hot-mix asphalt (HMA)) has been shown to result in a 20 to 25 percent reduction in energy usage.[81] WMA use is increasing throughout California, the U.S., and Europe. A survey by the National Asphalt Pavement Association found that nearly one third of all asphalt pavement mix production in the U.S. is WMA, an increase of 577 percent since 2009.[82]

Economic Feasibility

The cost of plant modifications to produce WMA range from $30,000 to $50,000. Additionally, the chemistry used to bind the aggregate is approximately $3 to $5 per ton more expensive than HMA. However, many facilities realize a cost savings from the process because of reduced fuel and labor costs. The WMA makes compaction easier, and the lower temperatures result in reduced transportation costs. Additionally, facilities realize a cost savings from higher reclaimed asphalt pavement content. Overall, there is no expected cost increase.

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure*
BACM/BACT	TBD	Feasible	Feasible	No
Additional feasible measure		Feasible	Feasible	No
MSM		Feasible	Feasible	No

* While this measure is technologically and economically feasible in practice it is currently infeasible due to other considerations.

Other Considerations

In a white paper developed by the South Coast AQMD in 2008, staff concluded that lower-energy warm mix asphalt technologies were promising in reducing energy use and reducing NOx and VOC emissions. Nonetheless, the impact of mix and structural design, material processing requirements, construction

[80] D. Jones, F. Farshidi, J. Harvey; Warm-Mix Asphalt Study: Summary Report on Rubberized Warm-Mix Asphalt Research (Summary Report UCPRC-SR02013-03), March 2014

[81] South Coast AQMD, Technology Assessment – Rule 1108 Cutback Asphalt, June 2008

[82] National Asphalt Pavement Association, Steady Increase in Sustainability of Asphalt Pavements, http://www.asphaltpavement.org/index.php?option=com_content&view=article&id=1077:steady-increase-in-sustainability-of-asphalt-pavements&catid=24:napa-news4&Itemid=767, accessed January 19, 2016.

procedures, and quality control specifications were not yet fully evaluated. In the last few years, WMA has been increasingly popular in the United States. Caltrans promotes the use of WMA because of its many improvements over HMA. In its April 2013 publication, Caltrans reported a 30 percent potential fuel savings and an 18 percent reduction in the overall GHG emissions associated with WMA.[83] The University of California Pavement Research Center (UCPRC) investigated the performance of rubberized WMA and found that in a controlled environment, rubberized WMA have better workability, and could result in potential energy savings and safer working conditions compared to HMA.[84] WMA suppliers reported 19–50 percent VOCs reduction and 60–70 percent NOx reduction in plant emissions in Europe, although increased emissions of VOCs and CO were observed in the United States.[85] Although the overall performance of WMA seemed promising, mixed results were revealed on the potential emission reductions in a field test. UCPRC measured VOCs and semi-volatile organic compounds (SVOCs) emissions from WMA and HMA at the pavement surface during construction. Results showed that depending on the mix type and the temperature inside the chamber, total reactive organic gases (ROG) emission flux of WMA could be higher or lower than HMA.[11] Based on current information, the emission reduction of WMA technology is still uncertain and the potential increase in VOC emissions needs to be further investigated. Although VOCs are not a significant PM2.5 precursor in the South Coast Air Basin, the Basin is in "extreme" nonattainment of multiple ozone NAAQS and potential increases in VOC emissions must be carefully evaluated. Therefore, staff suggests further evaluation of the emission reduction and cost-effectiveness for WMA technology prior to being considered as BACM/MSM.

Potential Control Measure 13 - Paving Unpaved Lots, Roads, and Shoulders

Target Pollutant

PM2.5

Synopsis

This measure will examine the feasibility of reducing PM2.5 emissions from well-traveled or highly used unpaved lots, roads, and other surfaces by applying paving materials. Although the South Coast Air Basin is a highly urbanized environment, there are areas with unpaved surfaces that are used by vehicles, equipment and/or other activities that generate airborne particulate matter emissions, including PM2.5.

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[83] California Department of Transportation. Caltrans Activities to Address Climate Change: Reducing Greenhouse Gas Emissions and Adapting to Impacts. April 2013. Retrieved from: http://www.dot.ca.gov/hq/tpp/offices/orip/climate_change/documents/Caltrans_ClimateChange Rprt-Final_April_2013.pdf

[84] Jones, D., Wu, R., Barros, C. and Peterson, J. Research Findings on the Use of Warm-Mix. February 213. http://ra-foundation.org/wp-content/uploads/2013/02/040-PAP_060.pdf

[85] U.S. Department of Transportation, Washington, DC, USA. Warm-Mix Asphalt: European Practice; International Technology Scanning Program, FHWA-PL-08-007. February 2008

In total, there are approximately 1,900 miles of unpaved roads in the Basin. However, not all of these roads are well-traveled or highly used. The focus of this measure would be to reduce dust and PM2.5 emissions from unpaved surfaces located in high traffic areas that are produced by moderate to high vehicle and/or machinery activity. This includes, but is not limited to, unpaved parking lots near warehouses as well as unpaved areas used by mobile homes or other vehicles/equipment on a frequent basis. This measure does not include paving in natural or protected lands. The following sites with unpaved surfaces may be considered: roads, traffic areas, parking lots, staging or assembly areas, mobile home parks, equipment storage lots, runways, loading and unloading areas, and/or roads and other areas on agricultural lands. The following activities are not considered by this proposed control measure: routine maintenance and rehabilitation projects, and/or paving activities that are part of new development projects.

Unlike SJVAPCD Rule 8061, South Coast AQMD's rules do not currently prohibit the construction of new unpaved roads in urban areas. Therefore, this measure will also examine the feasibility incorporating this prohibition into South Coast AQMD rule requirements.

Potential Emission Reduction

The 2030 baseline inventory is 1.67 tpd of PM2.5 for this source category.

Estimated emission reductions are TBD.

Technological Feasibility

Roadway paving is a common activity and occurs regularly throughout the Basin in construction projects and other community improvement initiatives. Other air districts have implemented unpaved road dust control measures that include paving as one method of controlling particulate matter emissions. Some have established traffic thresholds that would trigger the paving requirements set therein, and methodologies for PM emissions quantification.[86,87] The South Coast AQMD has recently developed a Paving Project Plan for the Eastern Coachella Valley as part of the AB 617 Community Air Protection Program (CAPP), which has been approved by CARB. This plan was developed in response to community concerns related to particulate matter emissions from unpaved surfaces in the community of Eastern Coachella Valley. This paving plan includes an emissions reduction quantification methodology based on Vehicle Miles Traveled (VMT).[88] The quantification methodology has been approved by CARB and can be applied to this PCM for paving of unpaved surfaces in the Basin.

[86] San Joaquin Valley Air Pollution Control District Rules 8061– Paved and Unpaved Roads, August 2004 and 8071 – Unpaved Vehicle and Equipment Traffic Areas, September 2004 https://www.valleyair.org/rules/currntrules/r8061.pdf; https://www.valleyair.org/rules/currntrules/r8071.pdf

[87] Imperial County Air Pollution Control District Rule 214.2 – Paving Unpaved Roads Emission Reduction Credits, April 2017 https://apcd.imperialcounty.org/wp-content/uploads/2020/01/1RULE214-2.pdf

[88] South Coast AQMD Final Paving Project Plan ECV, September 2022 http://www.aqmd.gov/docs/default-source/ab-617-ab-134/steering-committees/eastern-coachella-valley/final-ecv-paving-project-plan.pdf?sfvrsn=8

This PCM focuses on unpaved surfaces that are adjacent to high-traffic areas or highly used by vehicles and equipment causing the production of airborne particulate matter emissions, including PM2.5. An additional quantification methodology may be necessary to estimate the emissions reduced by paving surfaces based on square footage or similar measure within unpaved lots that are not open to through traffic, such as warehousing operations. The amount and locations of unpaved surfaces that would benefit from this PCM are currently unknown, however South Coast AQMD is aware of several locations that could benefit from this PCM based on high truck traffic areas, goods movement corridors, warehouse locations, as well as through concerns raised by the AB 617 communities and information provided by various other sources. For example, the AB 617 community of San Bernardino/Muscoy has identified unpaved areas associated with trucking and warehousing adjacent to Route 66/Cajon Blvd. as a high traffic unpaved area that may benefit from paving. An example of an unpaved surface in the Basin that is currently being used by trucks for parking is provided in Figure III-3.

FIGURE III-3
UNPAVED TRUCK LOT IN TORRANCE, CA

The method of implementation of this measure may include regulatory or incentive-based approaches. The Road Paving Plan for the ECV may offer a blueprint for funding paving opportunities in 617 communities within the Basin through incentives, but regulatory requirements may be necessary in non-617 areas or where incentive funding is otherwise unavailable.

Economic Feasibility

The cost projections of paving unpaved areas vary due to materials used for paving, be it asphalt, concrete, or some combination, and the need for striping, curbing, and other improvements. The Fugitive Dust Handbook published by the Western Regional Air Partnership estimates the costs of paving one mile of

unpaved road at $44,100/mile-year with an estimated useful life of 25 years; a similar cost estimate for paving unpaved lots $0.23/square foot-year for a useful life of 25 years, though these costs have likely increased since publication.[89] CARB's Unpaved Road Dust, Non-Farm Roads Methodology estimated the total unpaved city and county road miles for the Basin at 167.3 miles, though 'high-traffic' and adjacency to AB 617 communities were not limiting factors in these estimates.[90] Using these figures, a high cost estimate for paving the total unpaved city and county land in the Basin would be approximately $184 million, though again these are total miles not 'high-traffic' miles, so the total unpaved lot area that would be considered by this PCM would be significantly smaller. This methodology estimates that the tons of PM/year reductions of paving the total road miles at 553.3 tons/year, or 1.52 tpd for an estimated cost effectiveness figure of $13,334/ton. If only 10 percent of the road miles is paved this could result in a reduction of 55 tons/year of PM. While most unpaved roads are in public jurisdictions, many unpaved lots are private land and this distinction will be key to implementation of this PCM, as well defining high-traffic and distance to affected populations or AB 617 adjacency.

As the surface area of private unpaved high-traffic lots in the Basin is unknown, any incentive funding or cost-effectiveness estimates for the total unpaved area that this PCM may address is not known, and this uncertainty presents a barrier to feasibility. In addition, this PCM must be considered in the context of climate-related drought conditions and heatwaves frequently experienced in the Basin. Paving surfaces that would otherwise allow for underground aquifers to replenish during rainstorms must be acknowledged as a potential cost when assigning cost-effectiveness or designating areas for applicability to this PCM. Paving unpaved surfaces, especially in urban areas, also creates heat island effects resulting in higher temperatures than outlying areas. In densely urbanized areas, paved roads absorb and re-emit the sun's heat more than natural landscapes becoming "islands" of higher temperatures relative to outlying areas. The costs of less permeable areas for surface drainage and heat island effects are unknown at this time. Therefore, South Coast AQMD has determined that this PCM requires further evaluation before committing to an adoption schedule and emission reductions.

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure
BACM/BACT	TBD	Feasible	No	No
Additional feasible measure		Feasible	No	No
MSM		Feasible	No	No

[89]Western Regional Air Partnership Fugitive Dust Handbook, 2006 https://www.wrapair.org/forums/dejf/fdh/content/FDHandbook_Rev_06.pdf

[90] California Air Resources Board Miscellaneous Process Methodology 7.10, Unpaved Road Dust, Non-Farm Roads, 2012 https://ww3.arb.ca.gov/ei/areasrc/fullpdf/full7-10_2012.pdf

Other Considerations

South Coast AQMD has determined that further evaluation is required prior to implementing this control measure. Control measure BCM-19 proposes to develop an inventory of unpaved roads and parking lots within urban areas in the Basin and assess the suitability for paving. The proximity to AB 617 communities will be considered.

Potential Control Measure 14 - PM Controls for Industrial and Commercial Combustion Processes

Target Pollutant

PM2.5

Synopsis

This measure is based on U.S. EPA's Menu of Control Measures, which lists various control technologies (e.g., electrostatic precipitators, Venturi scrubbers, and fabric filters) for large heaters, boilers, and generic industrial combustion processes. Due to the South Coast Air Basin's "extreme" nonattainment status for all ozone standards, South Coast AQMD is required to implement clean fuels for boilers pursuant to CAA Section 182(e)(3). U.S. EPA most recently approved the clean fuels for boilers compliance demonstration as meeting applicable requirements for the 2015 ozone standard.[91] As implemented by Rules 1146, 2002, 2004, and 1303, the use of solid fuels, residual oil, and diesel for boilers is effectively prohibited. As a result, industrial and commercial combustion processes in the South Coast Air Basin typically burn natural gas or process gas, which is estimated to reduce over 90 percent of PM2.5 emissions compared to residual oil.[92]

Staff identified only one commercial application of stationary source diesel combustion in the Basin, which are engines that supply emergency backup power. All such engines > 50 horsepower are regulated by Rule 1470. Furthermore, new or modified units with ≥ 1,000 horsepower compression ignition engines are required to meet updated Lowest Achievable Emissions Rate (LAER) and BACT guidelines which require that the units achieve U.S. EPA's Tier 4 Final emission standards.[93] Existing Tier 2 units can achieve Tier 4 Final emission limits through the use of Diesel Particle Filters (DPF) and SCR.

This measure seeks to examine the feasibility of requiring further PM2.5 exhaust controls for natural gas and diesel fueled stationary source combustion processes.

[91] 88 FR 29539
[92] https://pm25.harcresearch.org/assets/FinalReport.pdf
[93] http://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2022/2022-sept2-030.pdf?sfvrsn=6You

Potential Emission Reduction

The 2030 baseline inventory is 5.20 tpd of PM2.5 for this source category.

Emission reductions cannot be estimated since emission reductions are already achieved in practice via implementing LAER and BACT requirements and existing rules.

Technological Feasibility

Natural gas is one of the cleanest burning of the commonly used fossil fuels (such as coal and oil) or biomass (such as wood and straw). PM emissions are negligible with natural gas fired boilers and heaters because of the low sulfur (less than 0.1 percent sulfur) and low ash content. PM emissions from natural gas combustion include both "filterable" and "condensable" portions of PM. Filterable PM is the portion of total PM that exists in the stack in either the solid or liquid state and can be captured by conventional PM control device such as filters, cyclones, ESPs or scrubbers. Condensable PM is the portion of the total PM that exists in vapor phase at stack conditions but condenses into PM in the cooler ambient air. Condensable PM is composed of organic and inorganic compounds and of submicron size. For industrial and commercial boilers, condensable PM has the same order of magnitude emission rates as filterable PM.[94]

There are limitations that make it technologically infeasible to install a PM control device for industrial and commercial natural gas combustion processes. First, filterable PM emissions from natural gas combustion are typically low to negligible because of the low sulfur and ash content and thus, installing a control equipment would not result in a significant reduction in PM2.5 emissions. Second, condensable PM exists as a gas in the stack and would not be effectively captured by bag filters or ESPs. Staff is not aware of PM2.5 controls being required or achieved in practice elsewhere in the United States for natural gas fired heaters and boilers.

Stationary emergency diesel combustion engines are used only for emergency purposes, such as backup power generation. Stationary emergency diesel engines are required to be certified to meet Tier 3 and Tier 4 emission limits based on the engine size, model year, and application pursuant to the U.S. EPA's National Emission Standards for Hazardous Air Pollutants (NESHAP) for stationary reciprocating internal combustion engines.[95] Stationary emergency diesel combustion engines with ≥ 1,000 horsepower are already subject to meeting updated LAER through BACT as required by Regulation XIII – New Source Review. Since these stationary emergency combustion engines are already required to meet the LAER Tier 4 Final emissions standards and are addressed by BACT, there is no further potential for reductions and therefore, further PM exhaust control is technologically infeasible.

[94] https://www3.epa.gov/ttn/chief/old/ap42/ch01/s04/final/c01s04_oct1996.pdf
[95] https://www.epa.gov/stationary-engines/fact-sheet-final-amendments-emission-standards

Economic Feasibility

Due to low to negligible emission reduction potential with a PM control device for natural gas fired boilers and heaters, installing a PM control device may not be cost-effective. Due to little to no potential for further PM reductions from stationary emergency diesel engines, PM control for these operations is not cost-effective.

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure
BACM/BACT	N/A	No	No	No
Additional feasible measure		No	No	No
MSM		No	No	No

Staff is not aware of this control measure having been implemented in another nonattainment area or having been achieved in practice in another state for natural gas fueled boilers and heaters. This PCM therefore does not meet U.S. EPA's definition of MSM. Staff also reviewed U.S. EPA's Technical Support Document (TSD) for the San Joaquin Valley contingency measures Federal Implementation Plan (FIP).[96] In the infeasibility justification TSD, U.S. EPA notes that "there are no known add-on particulate matter control devices in use" for natural gas fired boilers, steam generators, and process heaters and that New Source Performance Standards (NSPS) typically do not set particulate matter limits for natural gas-fired units. U.S. EPA did not consider this to be a potential control measure in the FIP.

Potential Control Measure 15 - Lowering NOx Emission Limits for Boilers, Steam Generators, and Process Heaters

Target Pollutant

NOx

Synopsis

South Coast AQMD Rule 1146 (Emissions of Oxides of Nitrogen from Industrial, Institutional and Commercial Boilers, Steam Generators, and Process Heaters; Amended December 4, 2020) establishes NOx emission limits for boilers, steam generators, and process heaters equal to or greater than 5 million British thermal units per hour (MMBtu/hr) rated heat input capacity. San Joaquin Valley APCD Rule 4320 (Advanced Emission Reduction Options for Boilers, Steam Generators, and Process Heaters Greater than

[96] https://www.regulations.gov/document/EPA-R09-OAR-2023-0352-0034

5.0 MMBtu/hr; Amended December 17, 2020) has more stringent NOx emission limits than South Coast AQMD Rule 1146 for boilers, steam generators, and process heaters greater than or equal to 5 MMBtu/hr. For natural gas-fired boilers between 5 and 20 MMBtu/hr, the NOx limit is 5 ppm in Rule 4320, while the corresponding NOx limits are 7 to 9 ppm via ultra-low NOx burner (ULNB) in Rule 1146. In addition, for natural gas-fired units that are greater than 20 MMBtu/hr, the NOx limit is 2.5 ppm in Rule 4320. This limit is lower than the one for South Coast, which is a NOx limit of 5 ppm via selective catalyst reduction (SCR) for natural gas burning Group I units (greater than or equal to 75 MMBtu/hr) and Group II units (greater than or equal to 20 and less than 75 MMBtu/hr). Rule 4320 has an option for facilities to pay an annual emission mitigation fee in lieu of meeting the NOx limits specified in the rule, until the NOx limits can be met. While Rule 4320 provides the flexibility to comply through mitigation fees, Rule 1146 includes mandatory emission limits.

Potential Emission Reduction

Estimated emission reductions are TBD.

Technological Feasibility

NOx emissions from boilers, steam generators, and process heaters can be controlled with combustion modifications such as ULNB system or with post-combustion controls such as SCR. SCR is used to control NOx emissions from combustion sources such as boilers. It uses a precious metal catalyst that selectively reduces NOx in the presence of ammonia. However, incomplete reactions of NOx and ammonia result in emissions of unreacted ammonia (also known as ammonia slip). Depending on the type of combustion equipment utilizing SCR technology, the amount of ammonia slip can vary between less than 5 ppm when the catalyst is fresh and 20 ppm at the end of the catalyst life. SCR technology is considered to be a Best Available Retrofit Control Technology (BARCT), if cost-effective, for controlling NOx emissions from existing combustion sources such as boilers and process heaters. SCR technology is scalable and generally utilized for units greater than 10 MMBtu/hr. Based on the information obtained through vendor discussions, achieving 5 ppm NOx limit with an ULNB without SCR is feasible only for certain applications and for new installations, and an SCR system would be needed to achieve a NOx limit below 5 ppm.

The NOx emission limit specified in Rule 1146 for natural gas-fired Group I units (i.e., units greater than or equal to 75 MMBtu/hr) is 5 ppm, which is met with the use of SCR. In addition, existing permitted, natural gas-fired Group II units (i.e., units between 20 and 75 MMBtu/hr) in South Coast AQMD are equipped with SCR. Based on the information obtained through vendor discussions, it is potentially feasible for some retrofit units to meet a NOx limit of 4 ppm or less through SCR control. However, there are several technical limitations for SCR retrofits to meet 4 ppm or less, such as the age, flow, and size of the catalyst bed of the existing SCR system. Another technical limitation is a potentially higher ammonia slip may occur to achieve a lower NOx limit. The typical ammonia slip permit limit on the existing SCR system is at 5 ppm. The existing catalyst bed might not be large enough to comply with both the lower NOx limit and the 5 ppm ammonia slip permit limit. For example, NOx emissions of 2.5 ppm could be potentially feasible for some units, but the level of ammonia slip might also be higher (i.e., 10 ppm). The most significant

constraint is the inadequate safety margin between the permitted limit and the actual emissions to account for fluctuations in external factors, such as ambient temperature or fuel heat input (i.e., gas Btu).

For natural gas-fired Group III units between 5 and 20 MMBtu/hr, the NOx emission limits specified in South Coast AQMD Rule 1146 are 7 to 9 ppm, which are primarily achieved through the use of ultra-low NOx burners. Based on the information obtained through vendor discussion, ULNB replacements on existing units could potentially meet 7 ppm or less and achieving the 5 ppm NOx limit without SCR is only feasible for certain applications and for new installations. Therefore, achieving a NOx limit of 5 ppm as specified in San Joaquin's rule would not be feasible and/or cost-effective for burner retrofits of all existing units.

San Joaquin Valley APCD Rule 4320's Tier 2 NOx limits require units between 5 and 20 MMBtu/hr input rating to meet 5 ppm and units with greater than a 20 MMBtu/hr input rating to meet 2.5 ppm by December 21, 2023, with an option to comply with a mitigation fee. In San Joaquin Valley, a very small subset of the universe between 5 and 20 MMBtu/hr is currently permitted with a NOx emission limit of 5 ppm. In addition, only one unit is currently permitted with a NOx emission limit of 2.5 ppm, which is equipped with low NOx burners and an SCR system. According to San Joaquin Valley APCD's final draft staff report,[97] the 5 ppm and 2.5 ppm NOx limits in Rule 4320 may be not achievable for all units due to space limitations and economic considerations. Most affected units have typically had several layers of controls and can only reach these new limits with post-combustion controls including SCR. Therefore, both 5 ppm and 2.5 ppm NOx emission limits are rather considered technology-forcing limits and in lieu of meeting these technology-forcing limits, facility operators can pay an annual emission mitigation fee until their units become ready to comply with the limits.

Based on the staff's analysis as well as the information from San Joaquin Valley's staff report, staff concluded that achieving the emission limits of 5 ppm or lower (e.g., 2.5 ppm) is not available for all applicable units in this source category in South Coast AQMD and thus, is not a technologically feasible measure. Proposed Control Measure L-CMB-02 addresses emissions from boilers subject to Rule 1146 as part of the 2022 AQMP. Staff will continue to monitor and assess feasibility of obtaining a lower NOx limit for boilers which is to be addressed as part of L-CMB-02.

Economic Feasibility

To be determined once the lower emission limits become technologically feasible to be implemented for this source category.

[97] https://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2020/December/final/13.pdf

Summary Table

Type of Analysis	Emission Reduction	Technological Feasibility	Economic Feasibility	Feasible Measure
BACM/BACT	TBD	Not feasible	To Be Determined	No
Additional feasible measure		Not Feasible	To Be Determined	No
MSM		Not Feasible	To Be Determined	No

South Coast Air Basin Attainment Plan for the 2012 Annual PM2.5 Standard

Appendix III

ATTACHMENT A: EVALUATION OF SOUTH COAST AQMD RULES

ATTACHMENT A-1

EVALUATION OF SOUTH COAST AQMD RULES AND REGULATIONS – PM RULES

Rule No.	Rule Title	Current Rule Requirements	Other Agencies' Rules and Federal Guidance[a] That Are More Stringent	BACM Evaluation
404	Particulate Matter - Concentration (Amended 2/7/86)	Atmospheric discharge from any source is required to meet the PM limits varying from 0.01 gr/dscf to 0.19 gr/dscf depending on exhaust flow rates.	Bay Area, Regulation 6, Rule 1 (Adopted 8/1/18) contains a maximum PM limit of 0.15 gr/dscf. There are differences in the applicability of this rule compared to Rule 404.	South Coast AQMD Rule 404 varies in stringency when compared to other Districts' requirements. Overall, Rule 404, when considered with Rule 405, meets BACT.
405	Solid Particulate Matter – Weight (Amended 2/7/86)	Atmospheric discharge from any source is required to meet the PM limits varying from 0.45 kg/hr to 13.6 kg/hr depending on process weight.	n/a[b]	Meets BACT.
444	Open Burning (Amended 7/12/13)	Contains requirements and prohibitions for open burning to minimize emissions and smoke impacts to the public; allows open burning on permissive burn days, provided a permit and burn authorization is obtained; establishes burn plan requirements for prescribed burns; sets daily maximum burn acreage for agricultural and prescribed burning.	San Joaquin Valley Rule 4103 (Amended 4/15/10) contains additional best management practices compared to Rule 444 such as best management practices to control open burning of weeds. Bay Area, Reg 5, sets requirements for open burning, and forbids recreational burning during curtailment periods.	In its TSD for the approval of Rule 444 into the California SIP published in 2013, EPA determined that with the exception of provisions about banning the burning of specific crops, Rule 444 is generally as stringent as or more stringent than analogous rules in other California Districts. Controls that address agricultural burning emissions are considered in the Control Measure Assessment section. Overall, Rule 444 provides BACT level of control for this source category.
445	Wood-Burning Devices (Amended 10/27/20)	No wood-burning device is allowed in any new development, unless it is a U.S. EPA certified wood-burning heater, a pellet-fueled wood-burning heater, a masonry heater, or a dedicated gaseous-fueled fireplace. PM2.5 mandatory burning curtailment (no-burn day) is declared in area < 3,000 ft above mean seal level and Basin-wide if daily PM2.5 is forecast to exceed 30 µg/m3 or an applicable concentration as set forth in PM2.5 Contingency Measures during wood-burning season from November to February. If the Basin fails to meet RFP requirement, meet any quantitative milestone, submit a quantitative milestone report, or attain the applicable PM2.5 standard by attainment date, seasonal wood-burning curtailment threshold could go down as low as 26 µg/m3. Rule does not apply to: residential/commercial properties where a wood-burning device is the sole source of heat; a low income household; residential/commercial properties with no existing natural gas service within 150 ft of the property line; residential/commercial properties located ≥ 3,000 ft AMSL; or ceremonial fires exempted under Rule 444.	San Joaquin Valley Rule 4901 (amended 6/20/19) effective 1/1/20, prohibits sale or transfer of a real property that has a wood-burning heater unless it is either EPA Phase II certified, is a pellet-fueled wood-burning heater exempt from EPA certification, or is rendered permanently inoperable and removed from the property. Effective 1/1/20, remodel of wood-burning fireplace or chimney where total cost exceeds $15,000 and local building permit is required, shall install only a gas-fueled, electric, exempt, or EPA certified wood burning heater at the time of installation.	Rule 445 does not contain resale and remodel provisions as does SJVAPCD Rule 4901. Staff thoroughly evaluates these and other provisions in Appendix III.

Rule No.	Rule Title	Current Rule Requirements	Other Agencies' Rules and Federal Guidance[a] That Are More Stringent	BACM Evaluation
1117	Emissions from Container Glass Melting and Sodium Silicate Furnaces (Amended 6/5/20)	There are no PM10 emission limits in Rule 1117.	San Joaquin Valley Rule 4353 contains a PM10 emission limit of 0.20 lbs per ton glass produced for container glass and flat glass.	Staff considered introducing PM10 emission limits in Rule 1117 and the assessment can be found in the Control Measure Assessment section.
1133, 1133.1	Rule 1133 - Composting and Related Operations – General Administrative Requirements (Adopted 1/10/03) Rule 1133.1 – Chipping and Grinding Activities (Amended 7/8/11)	Rule 1133 is an administrative rule that requires composting, chipping, and/or grinding facilities to register with the District. These facilities provide information such as types and amounts of feedstocks produced, and a description of the processes used at the facility. This information is updated annually. Rule 1133.1 establishes holding or processing time requirements for green waste and food waste chipping and grinding activities. The rule's objective is to prevent inadvertent decomposition occurring during chipping and grinding activities.	n/a[b]	Rule 1133.1 was amended in 2011 to better manage stockpile operations associated with chipping and grinding activities, which is to be consistent with current greenwaste material processing requirements established in Title 14 of the California Code of Regulations. Rule 1133.1 meets BACT.
1137	PM10 Reduction From Woodworking Operations (Adopted 2/1/02)	Require that woodworking operations send sawdust emissions either directly to a baghouse filter, or to a pneumatic conveyance device that leads to a baghouse filter.	n/a[b]	Meets BACT.
1138	Control Of Emissions From Restaurant Operations (Adopted 11/14/97)	Control Of Emissions From Restaurant Operations (Adopted 11/14/97)	Ventura Rule 74.25 (Adopted 10/12/04) has equivalent requirements as in Rule 1138. Bay Area Rule 2 of Regulation 6 (12/5/07) has emission standards of 0.74 lbs PM10 and 0.32 lbs VOC per thousand pounds of meat cooked for all chain-driven charbroilers; 1.0 lbs PM10 per thousand pounds of meat cooked for all under-fired charbroilers with combined total grill surface area of at least 10 square feet. San Joaquin Rule 4692 requires catalytic oxidizers for chain-driven charbroilers cooking 400 pounds of meat or more per week. This threshold is more stringent than Rule 1138 which applies to chain-driven charbroilers cooking 875 pounds of meat or more per week. Rule 4692 also requires that catalytic oxidizers achieve an 86% VOC and 83% PM reduction. Finally, Rule 4692 requires registration and reporting requirements for under-fire d charbroilers.	Most BAAQMD under-fired charbroiler facilities are too small to trigger the under-fired charbroiler requirements. The lower applicability threshold in SJVAPCD Rule 4692 is evaluated in the Control Measure Assessment section.
1140	Abrasive Blasting (Amended 8/2/85)	Set standards for the abrasives and require a visible emission evaluation to determine the impact of abrasive blasting operations on visibility.	n/a[b]	Rule 1140 is substantively similar to the California Code of Regulations, Title 17, Subchapter 6 — Abrasive Blasting provisions, which have been adopted by most California Air Districts. State law prohibits more stringent requirements. As such, Rule 1140 meets BACT.
1155	Particulate Matter Control Devices (Amended 5/2/14)	PM standards for PM control devices at 0.01 gr/dcsf for existing large baghouses >7500 square feet and best operational practices to reduce PM emissions.	n/a[b]	Meets BACT.

Rule No.	Rule Title	Current Rule Requirements	Other Agencies' Rules and Federal Guidance[a] That Are More Stringent	BACM Evaluation
1156	PM10 Emission Reductions from Cement Manufacturing Facilities (Amended 3/6/09)	PM standards for PM control devices (0.01 gr/dcsf for existing and 0.005 gr/dcsf for new devices) and best operational practices to reduce PM emissions from aggregate and related operations	n/a[b]	Meets BACT.
1157	PM10 Emissions Reductions from Aggregate and Related Operations (Amended 9/8/06)	Good operational practices to reduce PM emissions from aggregate and related operations. Establish source specific performance standards (no dust emissions exceeding 20 percent opacity, or no dust emissions exceeding 50 percent opacity, or no dust plume beyond 100 feet from any emission source, etc.) and specifying operational PM10 controls for various types of equipment, processes, storage piles, internal roadways at aggregate and related operations, and track-out of materials onto paved public roads	EPA promulgated standards for new hot mix asphalt facilities in Title 40, Chapter I, Part 60, Subpart I of the Code of Federal Regulations (40 CFR Part 60, Subpart I). Subpart I assigns a 20 percent opacity limit and a 90 mg/dscm (micrograms/dry standard cubic meter) PM content for fugitive emissions.	In its TSD for the approval of Rule 1157 into the California SIP published in 2011, EPA determined that Rule 1157 generally had the most stringent requirements and concluded that Rule 1157 fulfills BACM. Overall, Rule 1157 is as stringent as or more stringent than the other Districts' rules and meets the BACT requirements for this source category.
1186	PM10 Emissions from Paved and Unpaved Roads, and Livestock Operations (Adopted 7/11/08)	Requires good management practice such as clean-up of spills on public roadways, post-event street cleaning, routine sweeping using certified street sweeping equipment, new or widened roads to have improved road shoulders and treatment of livestock feed access lanes and cessation of hay grinding activities during high winds, etc.; Establish unpaved road treatment schedule for local jurisdictions in the Basin.	SJVAPCD Rule 8061 requires municipalities to sweep paved roads at least once per month with PM10 efficient units. For unpaved roads, on any unpaved road segment with 26 or more AADT, the owner/operator shall limit visible dust emission to 20% opacity and comply with the requirements of a stabilized unpaved road, or shall implement an APCO-approved Fugitive PM10 Management Plan; Within an urban area, requires all new roads to be paved.	In its TSD for the approval of Rule 1186 into the California SIP published in 2011, EPA determined that the requirements to ensure continued compliance added in the 2008 amendment further strengthens the SIP-approved version of this rule, which was determined to meet the BACM provisions. For the majority of the categories, Rule 1186 is as stringent as or more stringent than the other Districts' rules and provides BACT level of control. Potential measures to further reduce paved road dust emissions are considered in the Control Measure Assessment section.

[a] Other agencies' rules and regulations amended/adopted before March 2023 are included in this updated BACM evaluation.

[b] There are no analogous requirements in other air agencies that are more stringent than the South Coast AQMD rule being evaluated.

ATTACHMENT A-2

EVALUATION OF SOUTH COAST AQMD RULES AND REGULATIONS – NOx RULES

Rule No	Rule Title	Current Rule Requirements	Other Agencies' Rules and Federal Guidance[a] That Are More Stringent	BACM Evaluation
476	Steam Generating Equipment (Amended 10/8/76)	For equipment with maximum heat input rate > 50 MMBTU/hr, NOx emission limits are 125 ppm at 3% O2 on gas-fired equipment and 225 ppm at 3% O2 on liquid or solid-fired equipment, averaged over 15 minutes. In South Coast AQMD, one facility (Long Beach City SERFF) has 3 combustors subject to NOx limit of 150 ppm (24-hr average) per 40 CFR Part 60 Subpart Ea and Eb.	Maryland (Section 26.11.08 Control of Incinerators) NOx emission limits for two applicable facilities are 140 and 150 ppm respectively at 24-hr average, and 105 and 145 ppm respectively at 30-day average.	Steam generating equipment in South Coast AQMD is subject to requirements similar to those in Maryland on a 24-hr average basis (140 to 150 ppm in Maryland vs. 150 ppm in South Coast). The 2022 AQMP includes control measure L-CMB-09 which will further reduce NOx emissions at the Long Beach City SERFF with implementation scheduled by 2030. This measure is included in the PM2.5 Plan as BCM-07.
1110.2	Emissions from Gaseous- and Liquid-Fueled Engines (Amended 11/1/19)	The following NOx limits apply to all stationary and portable engines over 50 bhp. Stationary, non-emergency engines and biogas (landfill and digester gas) engines: • 11 ppm NOx New non-emergency engines with electrical generators: • 0.07 lbs NOx/MW-hr (or 2.5 ppm NOx) General low-useage engines: • 36 ppm NOx, engines ≥500 hbp • 45 ppm NOx, engines <500 hbp Low-usage biogas engines: • 36 x ECF ppm NOx, engines ≥500 hbp • 45 x ECF ppm NOx, engines <500 hbp	n/a[b]	Meets BACT.
1111	Reduction of NOx Emissions from Natural-Gas-Fired, Fan-Type Central Furnaces (Amended 10/1/21)	The maximum NOx limit from fan-type central furnaces is 40 ng/J. On or after 10/1/12, NOx limit is 14 ng/J for residential and commercial fan-type central furnaces. Mobile home furnaces NOx limit is lowered to 14 ng/J by 10/1/18. Alternate compliance plan with mitigation fees with varying compliance dates.	BAAQMD Regulation 9, Rule 4 establishes a zero NOx emission limit for new natural gas-fired space heaters with a capacity < 175,000 Btu/hr beginning in 2029.	BAAQMD's zero emission limits are further evaluated in Appendix III.
1117	Emissions from Container Glass Melting and Sodium Silicate Furnaces (Amended 6/5/21)	The following emission limits apply. • 0.75 lbs NOx/ton of glass pulled averaged over 30 days • 0.50 lbs NOx/ton of product pulled averaged over 30 days for sodium silicate furnaces • 30 ppmv NOx at 3% O2 or 0.036 lb/MMBTU of heat for auxiliary combustion equipment	n/a[b]	Meets BACT/BACM.

Rule No	Rule Title	Current Rule Requirements	Other Agencies' Rules and Federal Guidance[a] That Are More Stringent	BACM Evaluation
1118.1	Control of Emissions from Non-Refinery Flares (Adopted 1/4/19)	Flare gas NOx emission limits range from 0.018 lbs/MMBtu for produced gas to 0.025 lbs/MMBtu for major digester gas and landfill gas. All other flare gas including minor digester gas is required NOx emission limits at 0.06 lbs/MMBtu. Organic liquid storage has NOx emission limit at 0.25 lbs/MMBtu and organic liquid loading has NOx limit at 0.034 lbs/1,000 gallons loaded.	n/a[b]	Meets BACT/BACM.
1121	Control of Nitrogen Oxides from Residential Type, Natural Gas-Fired Water Heaters (Amended 9/3/04)	For natural gas-fired water heaters rated <75,000 Btu/hr, NOx emission limits: • 55 ppm for mobile home • 30 ppm for residential home • 15 ppm for water heaters ≤50 gallons	BAAQMD Regulation 9, Rule 6 establishes zero NOx emission limits.	BAAQMD's zero emission limits are further evaluated in Appendix III.
1134	Emissions of Oxides of Nitrogen from Stationary Gas Turbines (Amended 2/4/22)	Requirements that will remain in effect until 2024: Standard = Reference Limit x (Unit Efficiency/25%), where reference limit depends on size of units, varying from 9 ppm to 25 ppm. New emission limits become effective 1/1/24: • Liquid fuel turbines located on Outer Continental Shelf (OCS): 30 ppm NOx / 5 ppm NH3 • Natural gas, combined cycle turbine: 2 ppm NOx / 5 ppm NH3 • Natural gas, simple cycle turbine: 2.5 ppm NOx / 5 ppm NH3 • Produced gas: 9 ppm NOx / 5 ppm NH3 • Produced gas turbine located on OCS: 15 ppm NOx / 5 ppm NH3 Other: 12.5 ppm NOx / 5 ppm NH3.	San Joaquin Rule 4703 (Amended 9/20/07) has standards from 5–50 ppm depending on size of units. Combined cycle units > 10 MW has limit of 3 ppm.	NOx emissions range has a lower limit in San Joaquin Rule 4703 (5 ppm) than South Coast Rule 1134 (9 ppm), while the upper limit is lower in South Coast Rule 1134 (25 ppm) than San Joaquin Rule 4703 (50 ppm). Therefore, for the majority of the categories, Rule 1134 is as stringent as the other District's rules. In early 2019, South Coast AQMD staff performed a BARCT analysis based on technological and economic feasibility, and established BARCT emission limits for equipment subject to Rule 1134. As such, Rule 1134 reflects up to date BARCT requirements, which is equivalent to BACT.
1135	Emissions of Oxides of Nitrogen from Electricity Generating Facilities (Amended 1/7/22)	Electricity generating facilities (EGF) have NOx emission limits at 5 ppm for boilers (at 3% O2), 2 ppm for combined cycle gas turbines, and 2.5 ppm for simple cycle gas turbines (at 15% O2) that are fired on natural gas. Internal combustion engines firing diesel limit NOx emissions at 45 ppm (at 15% O2). All NOx limits are 60 minute averages.	n/a[b]	Meets BACT.
1146, 1146.1	Rule 1146 - Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters (Amended 12/4/20)	Rule 1146 NOx emission limits for industrial/commercial boilers, steam generators, and process heaters ≥ 5 MMBtu/hr: • Gaseous fuel: 30 ppm • Non-gaseous fuel: 40 ppm • Landfill gas: 25 ppm • Digester gas: 15 ppm • Atmospheric units (5–10 MMBtu/hr): 12 ppm • Group I (≥75 MMBtu/hr burning natural gas): 5 ppm • Group II (≥20 & <75 MMBtu/hr with gaseous fuels) ▪ Fire-tube boilers with previous limits 5–9 ppm: 7 ppm	San Joaquin Valley Rules 4306 and 4320 (Amended 12/17/20) require NOx limits for boilers, steam generators, and process heaters ≥ 5 MMBtu/hr. Rule 4306 Tier 2 NOx limits by 2023–2029: • Category A (>5–20 MMBtu/hr): ▪ Thermal fluid heaters: 9 ppm San Joaquin Valley Rule 4320 (Amended 12/17/20) provides advanced emission reduction options: (1) meet	Rules 1146/1146.1 currently limit NOx emissions from thermal fluid heaters to 12 ppm, while the Rule 4306 Tier 2 NOx limit is 9 ppm. Based on the Rules 1146/1146.1 staff report, an emission limit of 12 ppm was feasible for retrofits at the time of rule development, but an emission limit of 9 ppm is feasible for new burners upon replacement. For lowering the emission limit from 12 ppm to 9 ppm, the cost-effectiveness ranges from $58,000 to $523,000 per ton of NOx reduced based on the assumption of 10–90% operating capacity of the thermal fluid heaters at different heat capacity sizes. Therefore, due to high cost-

Rule No	Rule Title	Current Rule Requirements	Other Agencies' Rules and Federal Guidance[a] That Are More Stringent	BACM Evaluation
	Rule 1146.1 - Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters (Amended 12/7/18)	▪ All other units (with previous limits 5–12 ppm): 9 ppm ▪ All others: 5 ppm • Group III (≥5 & <20 MMBtu/hr with gaseous fuels) ▪ Fire-tube boilers with previous limits 9–12 ppm: 7 ppm ▪ All others: 9 ppm • Thermal fluid heaters: 12 ppm. Rule 1146.1 NOx emission limits for industrial/commercial boilers, steam generators, and process heaters between 2-5 MMBtu/hr: • Landfill gas: 25 ppm • Digester gas: 15 ppm • Atmospheric units (5–10 MMBtu/hr): 12 ppm • Fire-tube boilers: 7 ppm • Natural gas units: 9 ppm • Thermal fluid heaters: 12 ppm • All other units: 30 ppm Rules 1146/1146.1's compliance dates: • Non-RECLAIM facilities • 12/7/18 • 12/7/33 with a permit limit ≤ 20 ppm • 1/1/22 with a permit limit > 20 ppm • RECLAIM facilities ▪ 12/7/33 with a permit limit ≤ 20 ppm 1/1/22 with a permit limit > 20 ppm	the specific NOx emission limits, (2) pay an annual emissions fee, or (3) comply with low-use provision. Rule 4320 Tier 2 NOx limits are technology-forcing limits with compliance deadline by 2023: • Category A (>5–20 MMBtu/hr): ▪ Fire-tube boilers: 5 ppm ▪ Thermal fluid heaters: 9 ppm ▪ All others: 5 ppm • Category B (>20 MMBtu/hr): ▪ Fire-tube boilers >20–75 MMBtu/hr: 2.5 ppm ▪ All others >20–75 MMBtu/hr: 2.5 ppm ▪ All others >75 MMBtu/hr: 2.5 ppm	effectiveness of a 9 ppm emission limit, the 12 ppm NOx emission limit in Rule 1146 series is considered the BARCT level of control for the thermal fluid heaters. In general, the emission limits in San Joaquin Valley Rule 4320 are more stringent than those in Rule 1146 for boilers >5 MMbtu/hr. The NOx limits in Rule 4320 are technology-forcing limits with an option to comply by paying an annual emission fee in lieu of meeting the limits. Because Rule 4320 provides the flexibility to comply through mitigation fees, it is not evaluated against Rule 1146, which includes mandatory emission limits. A more extensive analysis to evaluate the feasibility of these emission limits is presented in the Control Measure Assessment section.
1146.2	Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters (Amended 12/7/18)	Applicable to natural gas-fired water heaters, boilers, and process heaters with heat rating ≤2 MMBTU/hr. As of January 1, 2010, any Type II unit between 400,000 Btu/hr and 2 MMBtu/hr is required to meet a 20 ppm NOx limit, and as of January 1, 2012, any Type I unit (except pool heaters) ≤400,000 Btu/hr is required to meet 20 ppm NOx limit. Effective January 1, 2000, new Type I units including pool heaters are required to meet the 55 ppm NOx limit, and new Type II units are required 30 ppm NOx limit.	n/a[b]	Meets BACM.
1147	NOx Reductions from Miscellaneous Sources (Amended 5/6/22)	Multiple NOx emission limits for gas and liquid fuel fired units. For unit heat rating ≥ 325,000 Btu/hr: • Gaseous fuel-fired equipment, including burnoff furnaces and incinerators with or without integrated afterburners, have 20-60 ppm NOx emission limits depending on application, process temperature, and implementation timeframes. • Micro-turbines must achieve 9 ppmv NOx. • Asphalt manufacturing must achieve 40 ppmv NOx.	n/a[b]	Meets BACT.

Rule No	Rule Title	Current Rule Requirements	Other Agencies' Rules and Federal Guidance[a] That Are More Stringent	BACM Evaluation
		Liquid fuel fired units are set at 40 ppm at process temperatures below 1,200 degrees Fahrenheit and 60 ppm above 1,200 degrees Fahrenheit.		
1153.1	Rule 1153.1 - Emissions of Oxides of Nitrogen from Commercial Food Ovens (Amended 8/4/23)	Commercial in-use food ovens set Phase I NOx limits at 30 ppm, except for tortilla ovens with IR burners the NOx limit is 15 ppm. Phase II zero emission limits for certain equipment types.	n/a[b]	Meets BACT.
1179.1	Emission Reductions from Combustion Equipment at Publicly Owned Treatment Works Facilities (Adopted 10/2/20)	Rule 1179.1 NOx emission limits for digester gas units at publicly owned treatment works facilities: 1) Digester gas or dual fuel boilers/process heaters • 90% digester gas >2 MMBtu/hr: 15 ppm • 100% natural gas >2 MMBtu/hr: 9 ppm • 100% natural gas ≤2 MMBtu/hr: 30 ppm 2) Turbines • 60% digester gas ≥0.3 MW: 18.8 ppm • 100% natural gas, simple cycle ≥0.3 MW: 2.5 ppm • 100% natural gas, combined cycle ≥0.3 MW: 2 ppm • Digester gas/dual fuel/natural gas <0.3 MW: 9 ppm 3) Digester gas and dual fuel engines • Engines >50 hp: 11 ppm	San Joaquin Valley Rules 4306 and 4320 (Amended 12/17/20) require NOx limits for boilers fired on digester gas >5–20 MMBtu/hr to be at 9 ppm.	For boilers fired on digester gas, the NOx limit in Rule 1179.1 (15 ppm) is not as stringent as the limit in San Joaquin Valley Rules 4306/4320 (9 ppm). 2022 AQMP control measure L-CMB-08 seeks to lower the NOx limit to 9 ppm by requiring ultra-low NOx burners for digester gas fueled boilers. Staff analysis determined that L-CMB-08 cannot be feasibly implemented until after 2030.
2002	Allocations for Oxides of Nitrogen (NOx) and Oxides of Sulfur (SOx) (Amended 10/5/18)	Includes facility allocations for NOx for Regional Clean Air Incentives Market (RECLAIM) facilities. Each RECLAIM facility is required to have adequate RECLAIM trading credits (RTCs) to offset its quarterly and annual NOx emissions. Emission reduction target is set by decreasing level of allocations, and these RECLAIM allocations are established and updated based on Best Available Retrofit Control Technology (BARCT) emission limits. RECLAIM NOx emission limits for refinery boilers, heaters, and steam generators are: • <20 MMBtu/hr: 12 ppm • 20–40 MMBtu/hr: 9 ppm • >40 MMBtu/hr: 2 ppm	San Joaquin Valley Rule 4306 (Amended 12/17/20) requires Tier 2 NOx limits for refinery boilers, steam generators, and process heaters ≥ 5 MMBtu/hr as follows with compliance deadline by 2023: • ≤40 MMBtu/hr: ○ Boilers: 30 ppm & 5 ppm upon replacement San Joaquin Valley Rule 4320 (Amended 12/17/20) provides advanced emission reduction options, whereby either (1) meet the specific NOx emission limits, (2) pay an annual emissions fee, or (3) comply with low-use provision. Rule 4320 Tier 2 NOx limits for refinery units are technology-forcing limits with compliance deadline by 2023 as follows: • Boilers/process heaters >5–40 MMBtu/hr: 5 ppm	Refinery boilers and heaters are currently regulated under RECLAIM (Regulation XX) in the South Coast AQMD. For the units ≤40 MMBtu/hr, NOx emission limits are at 9–12 ppm, while San Joaquin Valley Rule 4306 NOx limits are at 30 ppm and 5 ppm upon replacement at the end of the useful life of the equipment to increase the cost-effectiveness of the requirement. Therefore, the NOx limits in Rule 2002 are more stringent than in Rule 4306 for existing units. Because Rule 4320 has an option to comply through mitigation fees, it is not evaluated against Rule 2002. As the RECLAIM program transitions to the command-and-control regulatory structure, refinery boilers are required to meet NOx emission limits under Rule 1109.1 (Emissions of Oxides of Nitrogen from Petroleum Refineries and Related Operations), adopted 11/5/21. Rule 1109.1 requires boilers <40 MMBtu/hr to be 40 ppm on or before 7/1/22 and 5 ppm afterwards. These limits were determined from a comprehensive BARCT assessment that took both technological feasibility and cost-effectiveness into account. Lowering the NOx limit for refinery boilers to 30 ppm was not cost-effective. Refer to Rules 1146 and 1146.1 for the evaluation of non-refinery units. Overall, staff concludes that South Coast AQMD's RECLAIM NOx emission

Rule No	Rule Title	Current Rule Requirements	Other Agencies' Rules and Federal Guidance[a] That Are More Stringent	BACM Evaluation
				limits for refinery boilers and heaters are at least as stringent as San Joaquin Valley Rule 4306, and meet BACT.

[a] Other agencies' rules and regulations amended/adopted before March 2023 are included in this updated BACM evaluation.

[b] There are no analogous requirements in other air agencies that are more stringent than the South Coast AQMD rule being evaluated.

ATTACHMENT A-3

EVALUATION OF SOUTH COAST AQMD RULES AND REGULATIONS – NH3 RULES

Rule No	Rule Title	Current Rule Requirements	Other Agencies' Rules and Federal Guidance[a] That Are More Stringent	BACM Evaluation
223	Emissions Reduction Permits From Large Confined Animal Facilities (Adopted 6/2/06)	Sets permit requirement for new and modified LCAF facilities. Specifies mitigation options by animal and facility type for: • Feed and silage handling, • Milk parlor operations, • Corrals and free stall barn operations, • Handling of manure and solids, • Handling of manure in liquid form • Land application of liquid or solid manure	SJVAPCD Rule 4570 is more stringent regarding applicability than Rule 223 for milk cows, (1,000 milk cows in South Coast AQMD vs 500 milk cows in SJVAPCD), and for chickens and ducks (650,000 birds in South Coast AQMD vs. 400,000 birds in SJVAPCD). However, that is partly mitigated by South Coast AQMD Rule 1127 which has a much lower applicability thresholds of 50 or more cows, heifers and/or calves. Rule 223 also has a lower applicability for horse facilities (2,500 in South Coast AQMD vs. 3,000 in SJVAPCD). Rule 4570 sets comparable permit requirements and mitigation measures.	Staff evaluated the potential to achieve further NH3 emission reductions from livestock waste in the Control Measure Assessment section.
1127	Emission Reductions from Livestock Waste (Adopted 8/6/04)	Requires Good housekeeping practices for dairy farms with 50 or more cows, heifers and/or calves. Note: The South Coast AQMD adopted Rule 223 in June 2006 to reduce emissions for large confined animal facilities. Rule 223 includes series of best management practices that are more stringent than those required by Rule 1127.	Sacramento Rule 496 – Large Confined Animal Facilities (Adopted 8/24/06), has more stringent control and good management practices than South Coast Rule 1127 (e.g. venting to control system with at least 80% control efficiency). The more stringent requirements are targeted towards silage emissions, which is not applicable in South Coast for dry feed lot operations. SJVAPCD Rule 4565 and 4566 sets comparable permit requirements and mitigation measures. SJVAPCD 4570 has required best management practices for manure management and other areas to reduce VOC and ammonia emissions. Note that direct comparison with Rule 1127 is difficult due to the significant differences in source operations (dry feed lot in South Coast vs. flushing and lagoon operations in San Joaquin, the focus on corral waste control in South Coast AQMD vs. feed and silage and milk parlor in SJVAPCD, etc). In addition, SJV Rule 4570 applies to all types of confined animal facilities, while Rule 1127 applies only to dairies with a much lower applicability threshold.	Staff evaluated the potential to achieve further NH3 emission reductions from livestock waste in the Control Measure Assessment section.
1133.2, 1133.3	Emission Reductions from Co-Composting Operations (Adopted 1/10/03), Emission Reductions from Greenwaste Composting Operations (Adopted 7/8/11)	Various performance standards. Air pollution control must have 80% control efficiency or greater. Existing operations must reduce up to 70% baseline VOC and ammonia emissions. Baseline emission factors are 1.78 lbs VOC/ton throughput and 2.93 lbs NH3/ton throughput.	San Joaquin Rule 4565 – Biosolids, Animal Manure, and Poultry Litter Operations (Adopted 3/15/07) and Rule 4566 – Organic Material Composting Operations (Adopted 8/18/11) have various operational requirements for these operations as well as the operators who landfills, composts, or co-composts these materials. The applicability of Rules 4565/4566 is	South Coast AQMD Rule 1133.2 is more stringent than San Joaquin's Rule 4565 for larger co-composting facilities and less stringent for smaller co-composting facilities. While South Coast AQMD Rule 1133.2 requires either 70 or 80% overall emission reductions from all parts of composting process, San Joaquin's Rule 4565 requires add-on controls to apply only to the active composting phase. Rule 1133.2 also

Rule No	Rule Title	Current Rule Requirements	Other Agencies' Rules and Federal Guidance[a] That Are More Stringent	BACM Evaluation
		Rule 1133.3 establishes operational best management practices (BMPs) for greenwaste composting operations. If the facility processes more than 5,000 tons per year of foodwaste, any active phase of composting containing more than 10% foodwaste, by weight, must use an emission control device with an overall control efficiency of at least 80% by weight of VOC. For operations less than 5000 tons/year, require the composting piles to be covered, watered, and turned, or operated with measures that reduce at least 40% VOC emission and 20% NH3 emissions.	broader than the applicability of Rule 1133.3. In addition, Rules 4565/4566 include additional mitigation measures to control VOC from composting active piles (e.g. maintain minimum oxygen concentration of 5%, moisture content of 40%-70%, carbon to nitrogen ratio of 20-1).	has more stringent requirements for in-vessel composting. San Joaquin's rule does not address chipping & grinding as does Rule 1133.1. Overall, Rules 1133.2 and 1133.3 are as stringent as or more stringent than other Districts' rules, and meet the BACT requirement for this source category. Staff evaluated the potential to achieve further NH3 emission reductions from composting in the Control Measure Assessment section.

[a] Other agencies' rules and regulations amended/adopted before March 2023 are included in this updated BACM evaluation.

South Coast Air Basin Attainment Plan for the 2012 Annual PM2.5 Standard

Appendix III

ATTACHMENT III-B: MOST STRINGENT MEASURES ANALYSIS OF CARB'S CONTROL PROGRAMS

Table of Contents

Tables in the Document

Figures in the Document

Executive Summary

The Clean Air Act (the Act) specifies required levels of emission controls in a State Implementation Plan (SIP), depending upon the severity of the air quality problem and amount of time in which a nonattainment area needs to meet the PM2.5 standard. The State has conducted this analysis for each State-regulated source category emitting direct PM2.5 and relevant precursors in the South Coast Air Basin (South Coast). The suite of control measures that is currently being implemented by California Air Resources Board (CARB or Board) – both the current control program and new measures proposed for the South Coast – satisfy the applicable Most Stringent Measures (MSM) control requirements for the 2024 12 µg/m3 annual PM2.5 Plan. This analysis finds that California's mobile source control program is the most stringent and far-reaching suite of mobile source control measures that is currently implemented in the nation meeting the required levels of emissions controls. Furthermore, California has committed to setting a zero-emission standard for residential and commercial space and water heaters, which, when it goes into effect, would be the most stringent of any state regulation of its kind in the U.S., and would exceed the stringency of federal requirements.

In conducting this analysis, CARB staff followed a four-step process of assessing California's control program. First, CARB staff identified mobile source and residential and commercial building appliance emissions as a significant contributor to ambient PM2.5 levels. Next, CARB staff identified potential control measures for each mobile source sector and the appliance sector, including an analysis of California's control program, other control measures in practice throughout the nation, control measures suggested by the public, and reconsideration of control measures that were previously considered to be infeasible (as applicable). Staff then assessed the stringency and feasibility of the potential control measures that were identified. And finally, while many of the measures identified in this analysis have already been adopted by CARB and submitted in the California SIP, additional control measures have been included in the 2022 State Strategy for the State Implementation Plan (2022 State SIP Strategy)[1] and will be commitments in the proposed South Coast SIP for the 2024 12 µg/m3 annual PM2.5 Plan.

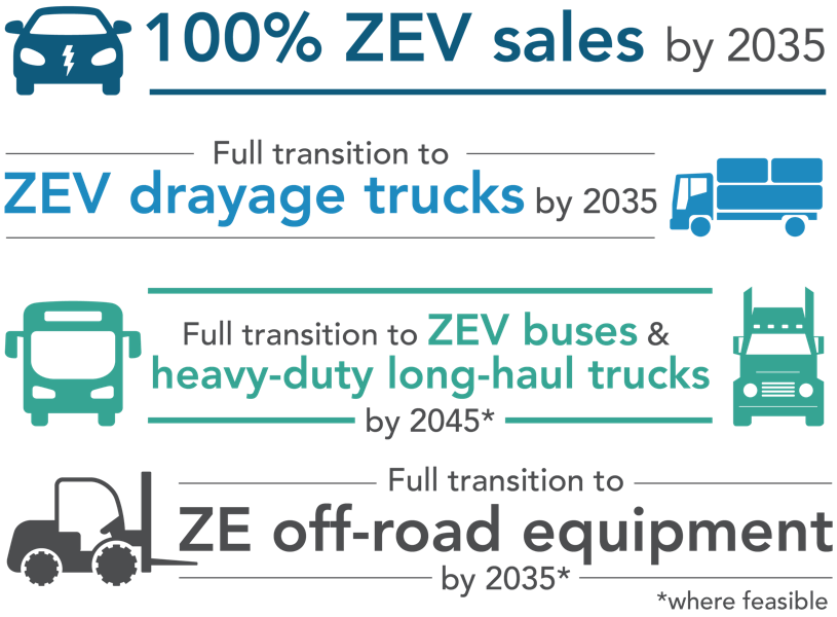
Given the severity of California's air quality challenges and the need for ongoing emission reductions, CARB has implemented the most comprehensive mobile source emissions control program in the nation. In aggregate, California's comprehensive suite of new vehicle and engine emission standards, in-use control measures, fuel specifications, and incentive programs for mobile sources represent the most stringent level of controls in the nation, and achieve the maximum feasible emission reductions for this category. CARB's comprehensive program relies on five fundamental approaches:

- Stringent emissions standards that minimize emissions from new vehicles and equipment;

[1] 2022 State SIP Strategy https://ww2.arb.ca.gov/resources/documents/2022-state-strategy-state-implementation-plan-2022-state-sip-strategy

- In-use programs that target the existing fleet and require the use of the cleanest vehicles and emissions control technologies;
- Cleaner fuels that minimize emissions during combustion;
- Incentive programs that remove older, dirtier vehicles and equipment and replace those vehicles with the cleanest technologies; and,
- Driving to zero-emissions for engines and powertrains where feasible, in accordance with the Governor's Executive Order N-79-20[2].

Figure 1: Transition from Combustion



This multi-faceted approach has spurred the development of increasingly cleaner technologies and fuels, and achieved significant emission reductions across all mobile source sectors that go far beyond national programs or programs in other states. These efforts extend back to the first mobile source regulations adopted in the 1960s, and predate the Act of 1970, which established the basic national framework for controlling air pollution. In recognition of the pioneering nature of CARB's efforts, the Act provides California unique authority to regulate mobile sources more stringently than the federal government by providing a waiver of preemption for its new vehicle emission standards for on-road vehicles and engines under Section 209(b), and authorizations for new off-road emission standards under Section 209(e)(2). These waiver and authorization provisions preserve a pivotal role for California in the control of emissions from new motor vehicles and engines, recognizing that California serves as a laboratory for setting mobile source emission standards. Since then, CARB has consistently sought

[2] California Executive Order N-79-20 https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf

and obtained waivers and authorizations for its new motor vehicle and off-road regulations. CARB's history of progressively strengthening standards as technology advances, coupled with the waiver and authorization process requirements, ensures that California's regulations remain the most stringent in the nation.

In 1998, CARB identified diesel particulate matter as a toxic air contaminant. Since then, CARB adopted numerous regulations aimed at reducing exposure to diesel particulate matter while concurrently providing reductions in oxides of nitrogen (NOx) from freight transport sources like heavy-duty diesel trucks, transportation sources like passenger cars and buses, and off-road sources like large construction equipment. Phased implementation of these regulations will continue to produce emission reduction benefits through 2030 and beyond, as the regulated fleets are retrofitted, and as older and dirtier portions of the fleets are replaced with newer and cleaner models at an accelerated pace.

Further, CARB and South Coast Air Quality Management District (South Coast AQMD) staff work closely on identifying and distributing incentive funds to accelerate cleanup of vehicles and engines. Key incentive programs include the Low Carbon Transportation, Air Quality Improvement Program, VW Mitigation Trust, Community Air Protection, Carl Moyer Program, Goods Movement Program, Clean Off-Road Equipment (CORE) and Funding Agricultural Replacement Measures for Emission Reductions (FARMER). These incentive-based programs work in tandem with regulations to accelerate deployment of cleaner technology.

California's programs are the most stringent in the nation for each category CARB regulates:

- California's control measures for the passenger vehicle fleet includes new vehicle emission standards, fuel specifications, and the most rigorous in-use inspection program for on-road light-and medium-duty vehicles in the country. The suite of on-road light-duty vehicle control measures included in the South Coast's plan is anticipated to achieve the maximum feasible emission reductions possible, and is comprised of the most stringent level of control measures for this category in the nation.

- California's heavy-duty on-road vehicle and engine control program is comprised of the most stringent emission standards for new engines in the nation (i.e., new vehicle tailpipe emission and evaporative emission standards; certification, testing, and verification requirements; warranty and useful life requirements, and OBD system requirements). Additionally, to reduce in-use emissions and accelerate fleet turnover to cleaner engines, California's in-use control measures include, in aggregate, the most stringent inspection and maintenance program, idling requirements, and legacy fleet requirements for on-road heavy-duty fleets in the nation. Finally, California's clean diesel regulations provide the most stringent emission controls in the nation for conventional and renewable diesel fuels and diesel substitute fuels. The suite of on-road heavy-duty control measures that will be included in the South Coast's plan is anticipated to achieve

the maximum feasible emission reductions possible, and is comprised of the most stringent level of control measures for this category in the nation.

- California's off-road engine and equipment control program includes the most stringent emission standards for new engines in the nation, comprehensive in-use fleet requirements to address emissions from the legacy fleets, and the cleanest off-road diesel fuel specifications in the nation. California's in-use control measures are national models for aggressive and successful efforts to reduce in-use emissions and accelerate fleet turnover to cleaner engines. In aggregate, the suite of off-road mobile source control measures that will be included in the South Coast's plan is anticipated to achieve the maximum feasible emission reductions possible, and is comprised of the most stringent level of control measures for this category in the nation.

- California's space and water heaters will include the most stringent emission standards of any state in the nation. For the first time, CARB will be setting an emission standard for space heaters and water heaters, to go into effect in 2030. CARB would adopt a statewide zero greenhouse gas (GHG) emission standard, which would have criteria pollutant co-benefits. Beginning in 2030, 100 percent of sales of new space heaters and water heaters would need to comply with the emission standard, the most stringent level of control measures for this category of any state in the nation.

Section I. Clean Air Act Requirements for Emission Control Measures

The particulate matter provisions in the Act establish a step-wise process for classifications and attainment dates:

- The first step is a Moderate area SIP, with an initial attainment date six years after the area is designated nonattainment;
- If attainment within six years is impracticable given the severity of the PM2.5 challenge in that area, then U.S. EPA re-classifies the area to Serious, and establishes requirements for a second SIP submittal that must show attainment within 10 years after the area was originally designated nonattainment.
- If the Serious area cannot show attainment within 10 years, the state can request an additional five-year extension if most stringent measures are in place and the State has met their obligations for the standard.

Likewise, the Act specifies a step-wise process for the required level of emission controls in a SIP, depending upon the severity of the air quality problem and amount of time a nonattainment area needs to meet the PM2.5 standard:

- For a Moderate nonattainment area, the required level of control is Reasonably Available Control Measures (RACM).[3]
- For a Serious PM2.5 nonattainment area, Best Available Control Measure (BACM) is the required level of control. U.S. EPA defines BACM to be the maximum degree of emission reductions achievable from a source or source category determined on a case-by-case basis considering energy, economic, and environmental impacts.[4]
- For a Serious PM2.5 nonattainment area for which air quality modeling demonstrates that the area cannot practicably attain by the end of the tenth calendar year (i.e. designated as “Serious with Extension”), MSM is the required level of control.[5] U.S. EPA defines MSM as, “the maximum degree of emission reductions that has been required or achieved from a source or source category in any other attainment plans or in practice in any other states and that can feasibly be implemented in the area.”[6] MSM is also inclusive of BACM requirements.
- For a Serious PM2.5 nonattainment area that has not attained by the applicable attainment date (i.e., designated as “Serious – 5% Plan”), the required level of control is also MSM.[7]

The South Coast is a Serious nonattainment area for its upcoming SIP for the 12 µg/m^3 annual PM2.5 standard discussed in this plan and will include an extension beyond ten years.

[3] RACM requirements are addressed in the Moderate SIP for the South Coast. For further information see https://ww2.arb.ca.gov/our-work/programs/california-state-implementation-plans/nonattainment-area-plans/south-coast-air
[4] U.S. EPA 1994 Addendum to the General Preamble p. 42010
[5] 40 CFR 51.1010(b)(2)(i)
[6] See U.S. EPA “Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements” pp. 326 July 2016 https://www.epa.gov/sites/production/files/2016-07/documents/pm25-naaqs-implementation-final-preamble-rule-signature.pdf
[7] 40 CFR 51.1003(c)(2)(i)

REQUIRED STRINGENCY OF CONTROL MEASURES

Based on the South Coast's current classification for 12 µg/m^3 annual PM2.5 standard, Table 1 describes the level of control measures required. The control measures for this plan must satisfy U.S. EPA's increasingly stringent Most Stringent Measures (MSM) requirements.

Table 1: Stringency of Control Measures Required[8]

Standard	Classification	Type of Plan	Control Measure Requirements
12 µg/m3 Annual (2012 Standard)	Serious with Extension	Most Stringent Measures (MSM)	**Most Stringent Measures** "The state shall identify, adopt, and implement the most stringent control measures that… can be feasibly implemented in the area." 40 CFR 51.1010(b)

DEFINING MOST STRINGENT MEASURES

MSM is the level of stringency required for the 12 µg/m^3 annual PM2.5 standard. The Act defines MSM as, "any permanent and enforceable control measure that achieves the most stringent emissions reductions in direct PM2.5 emissions and/or emissions of PM2.5 plan precursors from among those control measures which are either included in the SIP for any other National Ambient Air Quality Standard (NAAQS), or have been achieved in practice in any state, and that can feasibly be implemented in the relevant PM2.5 NAAQS nonattainment area."[9]

U.S. EPA guidance indicates that MSM is inclusive of the requirements and process for determining BACM.[10] The Act defines BACM as, "any technologically and economically feasible control measure that can be implemented in whole or in part within four years after the date of reclassification of a Moderate PM2.5 nonattainment area to Serious and that generally can achieve greater permanent and enforceable emissions reductions in direct PM2.5 emissions and/or emissions of PM2.5 plan precursors from sources in the area than can be achieved through the implementation of RACM on the same source."[11] U.S. EPA has further clarified that BACM-level of controls are:[12]

- The maximum degree of emissions reductions achievable from a source or source category, which is determined on a case-by-case basis considering energy, economic and environmental impacts;
- More stringent than RACM, but less stringent than the lowest achievable emission rate (LAER), which doesn't take into consideration the cost effectiveness of implementing a particular control measure;

[8] The proposed South Coast SIP has been developed to provide the necessary elements for the for the 12 µg/m3 Annual PM2.5 Standard, for which the South Coast is classified as nonattainment. This appendix has been developed to meet a subset of these requirements; namely the requirement that staff demonstrate that the control strategies for the South Coast's plan for the 12 µg/m3 Annual PM2.5 Standard satisfy U.S. EPA's requirements for Serious area attainment plan control strategy requirements, as set forth in § 51.1010, for the source categories of: mobile sources, and residential and commercial building appliances.

[9] Code of Federal Regulations (CFR) Title 40 – Protection of Environment § 51.1000 – Definitions https://www.gpo.gov/fdsys/pkg/CFR-2017-title40-vol2/xml/CFR-2017-title40-vol2-sec51-1000.xml

[10] U.S. EPA 2001 *Final TSD for Maricopa County PM10 Nonattainment Area*. Available at https://www3.epa.gov/region9/air/phoenixpm/pdf/tsd0901.pdf

[11] Code of Federal Regulations (CFR) Title 40 – Protection of Environment § 51.1000 – Definitions https://www.gpo.gov/fdsys/pkg/CFR-2017-title40-vol2/xml/CFR-2017-title40-vol2-sec51-1000.xml

[12] U.S. EPA 1994 "Addendum to the General Preamble" pp. 42009 -42013

- Additive to RACM, as BACM will generally consist of a more extensive implementation of RACM measures; and
- Inclusive of Best Available Control Technology (BACT).

U.S. EPA defines BACT similarly to BACM as an emission limitation based on the, "maximum degree of reduction of each pollutant emitted from or which results from any major emitting facility, which the permitting authority, on a case-by-case basis, taking into account energy, environmental, and economic impacts and other costs, determines is achievable for such facility through application of production processes and available methods, systems, and techniques." [13] BACT is also at least as stringent as new source performance standards (NSPS) and national emissions standards for hazardous air pollutants (NESHAPs)[14]

MSM is inclusive of the requirements for BACM, but with an additional step, comparing the potential MSMs identified against the measures already adopted in the area to determine if the existing measures are the most stringent.[15] Furthermore, U.S. EPA guidance defined MSM as "the maximum degree of emission reduction that has been required or achieved from a source or source category in any other attainment plans or in practice in any other states and that can feasibly be implemented in the area seeking the extension, such as what LAER represents for new or modified sources under the New Source Review permit program."[16]

[13] 42 U.S. Code § 7479 – Definitions https://www.gpo.gov/fdsys/pkg/USCODE-2011-title42/html/USCODE-2011-title42-chap85-subchapI-partC-subparti-sec7479.htm See § 7479(3) BACT

[14] U.S. EPA 1994 "Addendum to the General Preamble" pp. 42009 -42013

[15] U.S. EPA 2001 *Final TSD for Maricopa County PM10 Nonattainment Area*. Available at https://www3.epa.gov/region9/air/phoenixpm/pdf/tsd0901.pdf

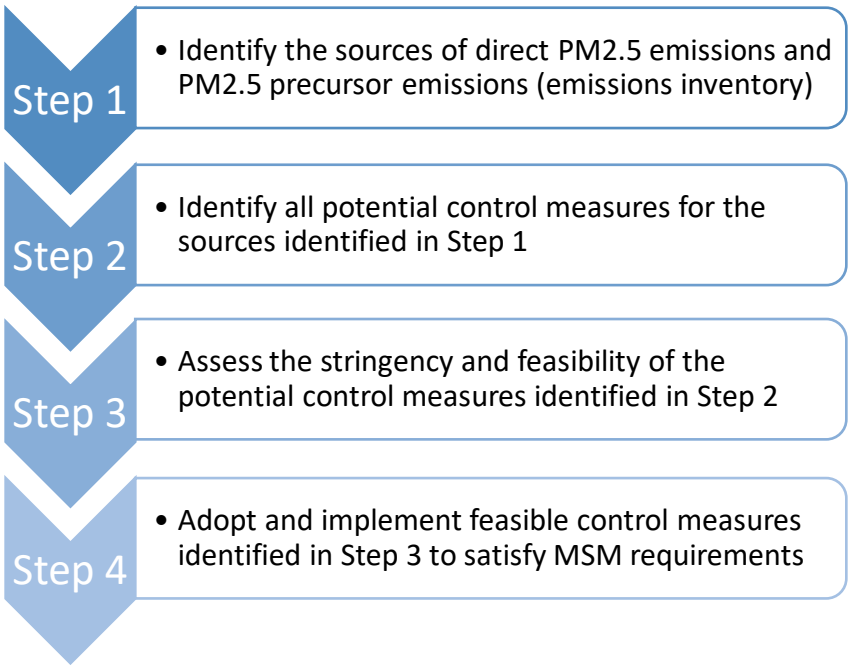
[16] U.S. EPA 1994. *Addendum to the General Preamble*, 59 FR 41998 page 42010

Section II. Process for Determining MSM

U.S. EPA prescribes a four-step process for the identification and determination of whether the control measures satisfy the Serious area attainment plan control strategy requirements.

The process for identifying MSM generally follow the same steps as the process for identifying BACM.[17] This is because the Serious area attainment plan control strategy requirements described in § 51.1010 are additive as the plans become more stringent. That is to say, the MSM requirements are inclusive of the requirements for BACM, with additional requirements added to reflect the increased stringency in control levels that result from a bump-up in classification.[18]

Figure 1: Process for Determining MSM



This process starts with identifying the sources of PM2.5 emissions (both direct and precursor emissions); then expands the analysis in Step 2 to identify all potential control measures that would reduce emissions. Step 3 begins to narrow the scope of analysis by refining the list of all potential control measures to determine which of the control measures are sufficiently stringent to meet the applicable MSM requirements, and to identify which are technically and economically feasible. The final step to adopt any control measures identified through this process, if they are feasible to implement in the South Coast.

Table 2 delves more deeply into this process, showing each required element in the steps listed above for both of the applicable PM2.5 Standards.

[17] In accordance with U.S. EPA's prescribed process described in the *TSD for the Maricopa County Serious Area PM10 Plan – 24-Hour Standard* (U.S. EPA 2001), which states, "Given this similarity between the BACM requirement and the MSM requirement, we believe that determining MSM should follow a process similar to determining BACM, but with one additional step, to compare the potentially most stringent measure against the measures already adopted in the area to determine if the existing measures are most stringent." Document is available at: https://www3.epa.gov/region9/air/phoenixpm/pdf/tsd0901.pdf

[18] § 51.1003(b)(2)(iii) requires that a submittal requesting a Serious area attainment date extension that is simultaneous with the Serious area attainment plan shall meet the most stringent measure (MSM) requirements set forth at § 51.1010(b), in addition to the BACM and BACT and additional feasible measure requirements set forth at § 51.1010(a)". For more details, see the Serious area attainment plan control strategy requirements identified in 40 CFR § 51.1010(a)(5), § 51.1010(b)(5), and § 51.1010(c)(5)

Table 2: MSM Requirements

Standard	12 ug/m3 Annual PM2.5 Standard (2012)
Classification	Serious with Extension
Control Strategy	MSM
Step 1: Identify sources of direct PM2.5 and precursor emissions (emissions inventory)	Required "The state shall identify all sources of direct PM2.5 emissions and sources of emissions of PM2.5 precursors in the nonattainment area in accordance with the emissions inventory requirements…" § 51.1010(b)(1)
Step 2: Identify all potential control measures	Required "The State shall identify all potential control measures to reduce emissions from all sources of direct PM2.5 emissions and sources of emissions of PM2.5 plan precursors" § 51.1010(b)(2)
Step 2(a): Begin with the area's current control measures	Recommended[19] "A state… should be able to start its process using the work already undertaken for the nonattainment area's RACM and BACM demonstrations and to make updates to the list of potential control measures"
Step 2(b): Survey other states and nonattainment areas for additional potential control measures	Required "The state shall identify the most stringent measures for reducing direct PM2.5 and PM2.5 plan precursors adopted into any SIP or used in practice to control emissions in any state" § 51.1010(b)(2)(i)
Step 2(c): Reconsider and reassess any measures previously rejected	Required "The state shall reconsider and reassess any measures previously rejected by the state during the development of any previous Moderate area or Serious area attainment plan control strategy" § 51.1010(b)(2)(ii)
Step 3: Assess potential control measures' stringency and feasibility	Required
Step 3(a): Evaluate stringency	Required MSM control levels required
Step 3(b): Assess technological and economic feasibility	Required "The state may make a demonstration that a measure identified… is not technologically or economically feasible to implement in whole or in part by 5 years after the applicable attainment date for the area, and may eliminate such whole or partial measure from further consideration" § 51.1010(b)(3) Assess the technological and economic feasibility of public measure suggestions submitted to CARB as potential control measures
Step 4: If found to be economically and technologically feasible, adopt control measures	Required "The state shall identify, adopt, and implement the most stringent control measures that are included in the attainment plan for any state or are achieved in practice in any state, and can be feasibly implemented in the area" § 51.1010(b)

[19] See U.S. EPA "Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements" July 2016 https://www.epa.gov/sites/production/files/2016-07/documents/pm25-naaqs-implementation-final-preamble-rule-signature.pdf

Step 1: Source Category Emissions of Direct PM2.5, NOx, and Ammonia

The first step required in the MSM evaluation process is to identify and quantify the sources of PM2.5, including direct PM2.5 emissions and emissions of precursor pollutants.

Mobile sources, and the fossil fuels that power them, continue to contribute a majority of NOx emissions, a significant precursor to the formation of particulate matter. On- and off-road heavy-duty mobile sources that burn diesel fuels, including trucks and off-road equipment, also directly emit PM2.5, as do sources primarily regulated at the federal and/or international level, including locomotives, ocean-going vessels, and aircraft. In the South Coast, air quality measurements and modeling have shown that emissions from mobile sources – cars, trucks, and a myriad of off-road equipment – are a significant contributor to ambient PM2.5 levels. Overall, mobile sources contribute to approximately 81 percent of NOx emissions, 17 percent of direct PM2.5 emissions, and 25 percent of ammonia emissions in the South Coast. In addition to directly emitted PM2.5, South Coast AQMD modeling demonstrated that gaseous precursors such as NOx and ammonia are the key precursors to atmospheric formation of PM2.5 in the South Coast, while VOC and SOX do not contribute significantly to ambient PM2.5 levels exceeding the NAAQS.

The formation of ammonia is a byproduct during the operation of a three-way catalyst (TWC). A TWC operates at near stoichiometric conditions, varying from slightly rich to slightly lean. Ammonia is generally formed during the slightly rich phase. Compressed Natural Gas (CNG) engines exhibit much higher ammonia than do gasoline engines. For diesel engines, ammonia emissions are inherently low as they do not use TWC technology. But newer engines employ Selective Catalytic Reduction (SCR). This technology uses ammonia for NOx aftertreatment. Unreacted ammonia can be emitted as part of this process (ammonia slip). Estimates of ammonia in emissions inventory models are informed by in-use data collected from dynamometer tests or portable emissions measurement systems (PEMS). Current on-road assumptions are documented in Section 3.3 of the EMFAC2021 technical documentation.[20] CARB programs that drive mobile sources to zero-emission vehicles and engines, including regulations such as the Advanced Clean Cars, Advanced Clean Trucks, and the Advanced Clean Fleets Regulations, will provide ammonia emission reduction benefits.

Residential and commercial buildings in California are the source of about 66 tpd NOx statewide due to natural gas combustion.[21] Nearly 90 percent of building NOx emissions are due to space and water heating, with the remaining 10 percent attributable to cooking, clothes drying, and other miscellaneous end uses. Space and water heating comprise nearly 90 percent of all building-related natural gas demand. Buildings also contribute to approximately 25 percent of California's GHG emissions when accounting for fossil fuels consumed onsite and through electricity demand as well as refrigerants

[20] https://ww2.arb.ca.gov/sites/default/files/2021-08/emfac2021_technical_documentation_april2021.pdf
[21] CARB's Criteria Emission Inventory CEPAM: 2019 Version - Standard Emission Tool

used in air conditioning systems and refrigerators. The fuels we use and burn in buildings, primarily natural gas, for space and water heating contribute significantly to building-related criteria pollutant and GHG emissions, and provide an opportunity for substantial emissions reductions where zero-emission technology is available.

Steps 2 and 3: Identification and Evaluation of Potential MSM Control Measures

The second and third steps required in the MSM evaluation process have been grouped together in this chapter so that the control measures for each sector can be more cohesively identified and evaluated.

STEP 2: IDENTIFICATION OF POTENTIAL MSM CONTROL MEASURES

Step 2 calls for the identification of all possible control measures for each of the sources of PM2.5 and NOx identified in Step 1.[22] To satisfy the Act's MSM requirements, this is a three-part process.

Step 2(a): California's Control Measures

The identification of all potential control measures begins with an analysis of California's control program. Due in part to the severity of its air quality needs, and in part to unique authority provided under the Act, California's mobile source controls go far beyond other states' and even national programs, and thus provides an excellent starting place in identifying a comprehensive range of mobile source control measures, as required by the Act. This approach also aligns with U.S. EPA guidance, which suggests starting the identification process with any controls previously identified in prior Moderate or Serious SIPs for the nonattainment area.[23]

Step 2(b): Other States' and Nonattainment Areas' Control Measures

The second component required to identify all potential MSM control measures is the identification of any additional control measures used in other states or nonattainment areas, and an assessment of their stringency relative to the control measures in the proposed South Coast SIP.[24, 25] The purpose is to identify whether there are additional potential MSM control measures used to control mobile emissions of direct PM2.5 and/or NOx in other states or nonattainment areas that are more stringent than the measures included in the proposed South Coast SIP. If this assessment finds that there are more stringent measures in use elsewhere – and if they are found to be sufficiently stringent and technically and economically feasible to implement in the South Coast (see Step 3) – the Act requires that any such measures are adopted and implemented

[22] In a departure from previous SIP guidance, EPA guidance indicates that are no *de minimis* source categories for this plan. Thus, emissions of direct PM2.5 and PM2.5 precursors (i.e. NOx) from all mobile source categories must be controlled in the South Coast, and meet the applicable MSM requirements. See U.S. EPA April 2016 "SIP Requirements Rule" 81 FR 58010 https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf

[23] U.S. EPA "Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements" July 2016

[24] § 51.1010(a)(2)(i), § 51.1010(b)(2)(i), and § 51.1010(c)(2)(i)

[25] U.S. EPA "Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements" July 2016

in the South Coast's plan (see Step 4), in order to meet the requirements that the area, "attain the standard as expeditiously as practicable."[26]

Identification

U.S. EPA guidance provides recommendations for possible resources to assist in the search for other control measures used in other states or nonattainment areas, including:[27]

- Other states' control programs (including those measures identified in U.S. EPA's list of national, state and/or local air quality agencies' control measures);[28]
- U.S. EPA's "Menu of Control Measures" for PM2.5; [29] and
- U.S. EPA's mobile-specific control measures for PM2.5.[30]

Beyond these suggested resources, CARB staff has also taken additional steps to identify any additional control measures currently in use in jurisdictions outside of California. This process included inquiries to U.S. EPA staff in Region 9, as well as inquiries to CARB technical staff that are engaged in developing control strategies across a wide range of sources throughout the agency, including passenger vehicles, heavy-duty trucks and buses, off-road equipment, and fuels. Furthermore, CARB staff has performed internet searches of other jurisdictions' control measures to ensure that our research process for this appendix identifies any control programs that have been more recently developed and which therefore may not otherwise be reflected in the abovementioned resources specified by U.S. EPA.

Assessment

In order to identify the most stringent suite of control measures currently, "adopted into any SIP or used in practice to control emissions in any state,"[31] CARB staff has identified in the tables included in Section IV Step 2(b) the most stringent suite of control measures in the nation, for each source category. Staff has assessed the relative stringency of measures based on the efficiency of a given measure or control technology to reduce the level of emissions from that source category – for example, by comparing the technical capacity for a given control measure to reduce in-use emissions from the on-road heavy-truck fleet, relative to other potential control measures that target the same emission source(s) for reductions. This assessment demonstrates that, for each source category, the suite of control measures included in

[26] § 51.1010(b)(4) and § 51.1004(a)(3)
[27] U.S. EPA April 2016 "SIP Requirements Rule" 81 FR 58010 https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf
[28] U.S. EPA https://www.epa.gov/pm-pollution/epa-summaries-and-reports-several-state-and-local-pm-control-measures. Accessed April 24, 2018
[29] U.S. EPA 2016 "*Menu of Control Options*" Accessed April 2018 at https://www.epa.gov/air-quality-implementation-plans/menu-control-measures-naaqs-implementation
[30] U.S. EPA https://www.epa.gov/advance/control-measures-programs-pm. Accessed April 24, 2018
[31] Per MSM requirements in 40 CFR § 51.1010(b)(2)(i) and § 51.1010(c)(2)(i), which call for the identification of the most stringent suite of control measures in any state or nonattainment area.

the proposed South Coast SIP are, in aggregate, the most stringent that are in use in any state or adopted into any SIP.

Step 2(c) Reconsideration and reassessment of any control measures previously rejected as infeasible

The final component required to identify all potential MSM control measures is to reconsider and reassess any control measures proposed in prior Moderate or Serious SIPs for the South Coast that were previously rejected as infeasible.[32]

CARB staff reviewed all previous South Coast PM2.5 SIPs[33] and found that we did not identify any mobile source control measures as infeasible in previous Moderate or Serious attainment plan control strategies for the South Coast.

During the public process for the 2022 State SIP Strategy, community-based organizations and members of the public suggested additional control measures that CARB could develop. Some of the public member suggestions have been integrated into measures committed to in the 2022 State SIP Strategy, while CARB staff is exploring the feasibility of a few remaining suggestions. The public measure suggestions, and any applicable resultant measures within the 2022 State SIP Strategy, are discussed below, and discussed in more detail in Section IV, Step 3(b): Evaluation of Feasibility, for each relevant source category.

Light-Duty Public Measure Suggestions:

- Enhanced Transportation Choices
  CARB staff is continuing to explore this suggested measure and how it can meet the Act requirements for SIP measure approvability.

- Enhanced Bureau of Automotive Repair Consumer Assistance Program
  CARB staff is continuing to explore this suggested measure and how it can meet the Act requirements for SIP measure approvability.

- Light-Duty Vehicle Fleet Regulation
  CARB staff is continuing to explore this suggested measure. CARB staff anticipate that the recently adopted Advanced Clean Cars II regulation, along with existing CARB regulations and current State incentive programs, achieve a significant amount of the benefits that this suggested measure would accomplish.

Medium- and Heavy-Duty Public Measure Suggestions:

- On-Road Heavy-Duty Vehicle Useful Life Regulation
  CARB staff has developed the Zero-Emission Trucks measure in response to receiving this public measure suggestion.

[32] Identification of any control measures that were previously rejected as infeasible in prior Moderate or Serious SIPs for the area is a requirement for MSM, not BACM. See 40 CFR § 51.1010(b)(2)(ii) and § 51.1010(c)(2)(ii)
[33] See CARB's list of South Coast Air Quality Management Plans at: https://ww2.arb.ca.gov/our-work/programs/california-state-implementation-plans/nonattainment-area-plans/south-coast-air

- Additional Incentive Programs: Zero-Emission Trucks
  CARB staff has developed the Zero-Emission Trucks measure in response to receiving this public measure suggestion.

Facility-Based Public Measure Suggestion:

- Indirect Source Rule
  CARB staff has been investigating the feasibility and potential benefits of this suggested measure, and is continuing to explore this suggested measure and how it can meet the Act requirements for SIP measure approvability. Nonetheless, CARB staff have included an Indirect Source Rule as one potential element of the Zero-Emission Trucks measure.

Commercial and Residential Building Appliances Public Measure Suggestion:

- Additional Building Emission Standards
  CARB staff has developed the Zero Emission Standard for Space and Water Heaters measure in response to receiving this public measure suggestion.

Other Public Measure Suggestions:

In addition to the above-described public measure suggestions for source categories included in this analysis, CARB also received additional public measure suggestions for categories that are not included in the scope of this analysis. This includes public measure suggestions for stationary sources (the BACT/BARCT Determination public measure suggestion) and for pesticides (the Pesticide Regulation public measure suggestion). The Pesticide Regulation public measure was developed into a measure for the 2022 State SIP Strategy, but which is not described in this analysis because ROG emissions are not a significant precursor emission to PM formation in the South Coast.

STEP 3: EVALUATION OF STRINGENCY AND FEASIBILITY

While the focus of Step 2 is on expanding the scope of analysis to ensure that all possible control measures are identified and incorporated into a list of potential MSM control measures, Step 3 focuses on narrowing that list to identify and discard from further consideration any measures that do not satisfy the applicable requirements for stringency and feasibility. Step 3 therefore calls for an evaluation of each of the potential MSM control measures identified in Step 2, in order to evaluate first whether they satisfy the required level of stringency of each control measure; and secondly, whether they are technically and economically feasible to implement in the South Coast.

Step 3(a): Evaluating Stringency

For a potential control measure to meet the definition of MSM, CARB staff must demonstrate that the measure satisfies stringency requirements in terms of both:

(i) the efficiency of a given measure or control technology to reduce the level of emissions from a specific mobile source, relative to emission controls in place in other states and nonattainment areas; and

(ii) the timing of when each control measure will begin to be implemented, relative to each plan's timing milestones and deadlines.

The Act defines feasibility in terms of both technological and economic feasibility. For the purposes of this analysis of control measures, the Act defines technological feasibility as, **"**factors including but not limited to a source's processes and operating procedures, raw materials, physical plant layout, and potential environmental impacts such as increased water pollution, waste disposal, and energy requirements."[34] Economic feasibility considerations include capital costs, operating and maintenance costs, and cost effectiveness of the measure.[35] Much of the assessment required to evaluate the efficiency of the level of control provided by a given control measure or technology is included in Step 2(b), wherein CARB staff analyzes the control measures in the South Coast's plan relative to those in other states and nonattainment areas.

The assessment of stringency also includes elements of timing, particularly regarding when a control measure will be implemented. U.S. EPA states that MSM should be implemented, "as expeditiously as practicable".[36] U.S. EPA also clarified the requirement for the analyses of the potential control measures, stating that the analysis should include a determination of the earliest date by which a control measure or technology can be implemented in whole or in part.[37] For the PM2.5 standard discussed in this plan, Table 3 summarizes the required levels of control measures, and the required timeframe for implementation in order to meet the definition of MSM.

Table 3: Implementation and Timing Requirements for MSM

Standard	12 ug/m3 Annual PM2.5 Standard (2012)
Classification Status	Serious with Extension
Type of Plan Required	MSM
Control Measure Requirements	MSM
Definition of MSM (regarding timing)	MSM: implemented in whole or in part by 5 years after the applicable attainment date for the area[38]
Attainment deadline	2030
Timeframe for Implementation	MSM if implemented $\leq$ 2035

Comparing the Stringency of the South Coast's Plan to the Current Control Program

The final step called for in U.S. EPA's process to demonstrate that the suite of control measures included in the proposed 2024 12 µg/m3 annual PM2.5 Plan satisfy the stringency definition for MSM is to compare the measures included in the South Coast's plan against the measures already adopted in the proposed South Coast SIP to

[34] 40 CFR § 51.1010(a)(3)(i)
[35] 40 CFR § 51.1010(a)(3)(ii)
[36] U.S. EPA, 2001 *Final TSD for Maricopa County PM10 Nonattainment Area* (page 31). Available at https://www3.epa.gov/region9/air/phoenixpm/pdf/tsd0901.pdf
[37] 87 FR 60494
[38] 40 CFR § 51.1010(b)(3)

determine if the existing control measures alone are more stringent.[39] CARB staff has compared the current control program to the control measures included in the South Coast's Plan, and has found that:

- The suite of control measures in the South Coast's proposed 2024 12 µg/m3 annual PM2.5 Plan include all of the potential MSM measures identified through the processes described above, including measures in the current control program.
- The suite of control measures in the South Coast's plan is more stringent than the existing control program alone because the plan encompasses both the existing suite of control programs and the new measures committed to in the 2016 and 2022 State SIP Strategies that have yet to be adopted. The new measures exceed the stringency of the current control program for control requirements applying to all mobile source categories, including the passenger vehicle fleet, the on-road heavy-duty fleet, and off-road equipment and engines, as well as residential and commercial building appliances source categories.

Step 3(b): Determination of Technical and Economic Feasibility

The second half of the required process for evaluating the potential MSM measures is an assessment of their economic and technical feasibility. As part of this process, the Act directs that the state may eliminate any control measures identified in Step 2 from further consideration if it is demonstrated to be technologically or economically infeasible to implement in the South Coast within the specified timeframes.

Per U.S. EPA's guidance and precedence, this requirement is not required to be applied unless a potential MSM control measure is rejected from inclusion in the SIP on the grounds of feasibility.[40] Nonetheless, CARB staff has conducted an initial assessment of technical feasibility for many of the mobile source control measures in the 2016 State SIP Strategy, and the 2022 State SIP Strategy, as well as through the technology assessments that CARB staff has conducted in collaboration with the South Coast AQMD. These Technology Assessments identified the current technological potential for more stringent emission control measures for on- and off-road heavy-duty applications, together with the fuels necessary to power them, along with ongoing review of advanced vehicle technologies for the light-duty sector.[41]

Additionally, an economic impact analysis was conducted for the newly proposed measures that were committed to in the 2022 State SIP Strategy.[42] Furthermore, all control measures that are regulatory in nature must also undergo a rule-specific, rigorous public review process when proposed by staff and/or approved by the Board, as specified by the Administrative Procedures Act (APA). These requirements include

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[39] U.S. EPA's 2001 *Final TSD for Maricopa County PM10 Nonattainment Area* see page 32. Available at https://www3.epa.gov/region9/air/phoenixpm/pdf/tsd0901.pdf

[40] See page 400 of U.S. EPA's 2001 *Technical Support Documentation for Maricopa County PM10 Nonattainment Area* https://www3.epa.gov/region9/air/phoenixpm/pdf/tsd30102.pdf where EPA staff explain that they are applying to Maricopa County's SIP the decision from a Phoenix Serious SIP not to apply this requirement if no potential control measures are rejected.

[41] Technology and Fuel Assessments http://www.arb.ca.gov/msprog/tech/tech.htm

[42] CARB 2022 "2022 State SIP Strategy Appendix A: Economic Analysis" https://ww2.arb.ca.gov/resources/documents/2022-state-strategy-state-implementation-plan-2022-state-sip-strategy

an Initial Statement of Reasons (ISOR) prepared for each proposed CARB regulation, an Environmental Analysis to satisfy California Environmental Quality Act (CEQA) requirements, and an Economic Analysis, including a Standardized Regulatory Impact Assessment (SRIA) for any proposed regulation has an economic impact exceeding $50 million.

While these processes occur beyond the requirements addressed in this plan, these requirements ensure there will be further opportunity for public and stakeholder input, as well as ongoing technology review and a more refined assessment of costs and environmental impacts as the measures move through CARB's public process for development into proposed regulations.

Step 4: Adopt and Implement Feasible Control Measures

The final step required by this step-wise process is to adopt and implement the feasible control measures identified in Step 3, in order to satisfy MSM requirements. Board adoption of the proposed South Coast SIP for the 12 µg/m^3 annual PM2.5 standard – including the control measures described in the 2022 State SIP Strategy – will satisfy the requirements of Step 4.

Section III. Step 1: Emissions of Direct PM2.5, NOx, and Ammonia

Table 4 shows the mobile source emissions of direct PM2.5, and Tables 5 and 6 show the mobile source emissions of NOx, and ammonia, the key precursors to secondary formation of PM2.5 in the South Coast.[43]

Table 4: Direct PM2.5 Emissions (tpd) from Mobile Sources in the South Coast

	2018	2030
On-Road Light-Duty Vehicles	2.4	2.1
On-Road Heavy-Duty Vehicles	3.2	1.6
Off-Road Federal and International Sources	1.7	1.8
Aircraft	0.7	0.7
Railroad	0.3	0.4
Ocean-Going Vessels	0.6	0.7
Off-Road Equipment	3.6	2.0
Total Direct PM2.5 from Mobile Sources	**10.8**	**7.4**

**Numbers may not add up due to rounding.*

Table 5: NOx Emissions (tpd) from Mobile Sources in the South Coast

	2018	2030
On-Road Light-Duty Vehicles	56.5	19.7
On-Road Heavy-Duty Vehicles	129.8	30.4
Off-Road Federal and International Sources	64.4	74.7
Aircraft	17.1	24.5
Railroad	15.1	17.7
Ocean-Going Vessels	32.2	32.6
Off-Road Equipment	72.6	37.9
Total NOx from Mobile Sources	**323.3**	**162.6**

**Numbers may not add up due to rounding.*

Table 6: Ammonia Emissions (tpd) from Mobile Sources in the South Coast

	2018	2030
On-Road Light-Duty Vehicles	2.4	12.3
On-Road Heavy-Duty Vehicles	3.2	8.8
Off-Road Federal and International Sources	1.7	0.0
Aircraft	0.7	0.0
Railroad	0.3	0.0
Ocean-Going Vessels	0.6	0.0
Off-Road Equipment	3.6	0.1
Total Ammonia from Mobile Sources	**10.8**	**21.3**

**Numbers may not add up due to rounding.*

[43] Data from SCAQMD, 2023. CEPAM version 101B

It is important to note that these tables reflect only a subset of the total emissions in the South Coast, and do not reflect emissions from stationary and areawide sources.

Many residential appliances, such as water heaters and furnaces, use natural gas or liquefied petroleum gas (fossil fuel) as a fuel source. These appliances have the potential to emit NOx during combustion. While emissions from buildings represent a small component of total PM2.5 and precursor emissions, water and space heaters comprise a large portion of total building-related emissions.

Section IV. Steps 2 and 3: Identification and Evaluation of Potential Control Measures

The second and third steps required in the MSM evaluation process – the identification of potential MSM control measures, and the evaluation of their stringency and feasibility – have been grouped together so that CARB staff can more cohesively identify and analyze control measures for each sector. The sectors analyzed include mobile sources (which are further broken down into sub-categories of passenger vehicles, on-road heavy-duty trucks and buses, and off-road mobile sources), and residential and commercial building appliances.

SECTION 209 WAIVER AND AUTHORIZATION AUTHORITY

Before delving into the sector-specific analysis, however, it is important to discuss the unique position California holds within the Act. In recognition of California's early efforts and extent of air quality challenges, the State has unique authority to regulate emissions from some mobile source categories more stringently than the federal government under the Act's §209(b) waiver provision and §209(b) authorization provision. This waiver provision also allows California to seek a waiver from U.S. EPA to enact more stringent emission standards for passenger vehicles and heavy-duty trucks. While U.S. EPA has primary authority for interstate trucks, aircraft, ships, locomotives, and some farm and construction equipment, the authorization provision allows California to seek authorization from U.S. EPA to enact more stringent emission standards for certain off-road vehicles and engines.

Due to California's unique waiver and authorization authority under the Act, no other state or nonattainment area has the authority to promulgate mobile source emission standards at levels that are more stringent than the federal standards. Other states can elect to match either the federal standards or the more stringent California standards. As such, no state or nonattainment area has a more stringent suite of mobile source emission control programs than California, implying a de-facto level of control at the level of MSM.

Over nearly five decades, CARB has consistently sought waivers and authorizations for its new motor vehicle regulations and has received waivers and authorizations for over 100 regulations. The most recent California standards and regulations that have received waivers and authorizations are:

- The Advanced Clean Cars (ACC) Regulations for light-duty vehicles (including the Zero-Emission Vehicle (ZEV) and the Low-Emission Vehicle III (LEV III) Regulations);
- On-Board Diagnostics II Requirements;
- The Advanced Clean Trucks Regulation;
- The Zero-Emission Airport Shuttle Bus Regulation;
- The Zero-Emission Power Train Certification;
- Heavy-Duty On-Board Diagnostics (HD OBD);
- The Heavy-Duty Vehicle and Engine Regulation;

- Heavy-Duty Vehicle and Engine Emission Warranty and Maintenance Provisions;
- Heavy-Duty Truck Idling Requirements;
- The Heavy-Duty Tractor-Trailer Greenhouse Gas (GHG) Standards;
- The In-Use Off-Road Diesel Fleets Regulation;
- The Non-Road Compression Ignition (CI) Regulation;
- The Large Spark Ignition (LSI) Engine and Fleets Regulation;
- The Portable Diesel Equipment Air Toxics Control Measure (ATCM);
- The Portable Equipment Registration Program (PERP);
- The Small Off-Road Equipment (SORE) Regulation;
- The Commercial Harbor Craft (CHC) Regulation;
- The Transport Refrigeration Unit (TRU) ATCM;
- The Off-Highway Recreational Vehicles Regulation;
- The Mobile Cargo Handling Equipment (CHE) Regulation; and
- The Spark Ignition Marine Engine and Boat Regulation.

Further, CARB has recently submitted waiver and authorization requests for:

- The Heavy-Duty Omnibus Regulation;
- The Small-Off Road Engine Standard (2021 Amendments);
- The Commercial Harbor Craft (CHC) Regulation (2022 Amendments); and
- The Transport Refrigeration Unit (TRU) Regulation Phase I (2022 Amendments).

CARB's history of progressively strengthening standards as technology advances, coupled with the waiver and authorization process requirements, ensures that California's regulations remain the most stringent in the nation, and that necessary emission reductions from the mobile sector continue. This provision preserves a critical role for California in the control of emissions from new motor vehicles, recognizing that California plays an important leadership role and serves as a "laboratory" state for more stringent motor vehicle emission standards. For example, CARB's LEV I and LEV II, and the ZEV Programs have resulted in the production and sales of over 1.5 million of ZEVs in California since first adopted them in 1990.

Additionally, CARB's 2022 State SIP Strategy[44] has developed and evaluated potential strategies for mobile source categories under CARB's regulatory authority that will contribute to expeditious attainment of the standards. This effort builds on the measures and commitments already made in CARB's multi-pollutant planning effort that have identified the pathways forward to achieve the State's many air quality, climate, and community risk reduction goals: the 2016 State SIP Strategy, and the 2020 Mobile Source Strategy.

With the 2022 State SIP Strategy, CARB explored and proposed an unprecedented variety of new measures to reduce emissions from the sources under our authority using all mechanisms available. The measures included in the 2022 State SIP Strategy encompass actions to establish requirements for cleaner technologies (both zero-emissions and near zero-emissions), deploy these technologies into the fleet, and

[44] CARB 2022 State Strategy for the State Implementation Plan (2022 State SIP Strategy) https://ww2.arb.ca.gov/resources/documents/2022-state-strategy-state-implementation-plan-2022-state-sip-strategy

to accelerate the deployment of cleaner technologies through incentives. As such, the measures included in the 2022 State SIP Strategy have been identified to push beyond the stringency of controls required in the current control program, and have been developed to achieve MSM definition of emission controls that achieve, "the maximum degree of emission reduction… that can be feasibly implemented in the area."[45]

The California regulations that comprise this rigorous suite of control measures are described in more detail in the following sections.

[45] U.S. EPA definition of MSM from the 2001 *Final TSD for Maricopa County PM10 Nonattainment Area* (page 31). Available at https://www3.epa.gov/region9/air/phoenixpm/pdf/tsd0901.pdf

On-Road Light-Duty Vehicles

On-road light-duty vehicles, often referred to as passenger vehicles, include motorcycles, passenger cars, and light to mid-sized trucks and SUVs. The vast majority of these vehicles currently have gasoline powered internal combustion engines, however this sector is projected to increasingly rely on electric drive vehicles of varying types (e.g. battery electric, plug-in hybrid, or fuel cell electric vehicles).

STEP 2(A): CALIFORNIA'S LIGHT-DUTY CONTROL MEASURES

Since setting the nation's first motor vehicle exhaust emission standards in 1966 that led to the first pollution controls, California has dramatically tightened emission standards for light-duty vehicles. Through CARB regulations, today's new cars pollute 99 percent less than their predecessors did in 1975. In 1970, CARB required auto manufacturers to meet the first standards to control NOx emissions along with hydrocarbon emissions, which together form smog. The simultaneous control of emissions from motor vehicles and fuels led to the use of cleaner-burning reformulated gasoline (RFG) that has removed the emissions equivalent of 3.5 million vehicles from California's roads.

Light- and medium-duty vehicles are currently regulated under California's ACC program, which includes the LEV III and ZEV programs. The ACC program combines the control of smog, soot-causing pollutants, and greenhouse gas emissions into a single coordinated package of requirements for model years 2015 through 2025. Since CARB first adopted it in 1990, the Low Emission Vehicle Program (LEV and LEV II) and Zero-Emission Vehicle (ZEV) Program have resulted in the production and sales of over 1.5 million (ZEVs) in California. Advanced Clean Cars 2 (ACC2), a measure from the 2016 State SIP Strategy, is a significant effort critical to meeting air quality standards that was adopted in August 2022. ACC2 has the goal of cutting emissions from new combustion vehicles while taking all new vehicle sales to 100 percent zero-emission no later than 2035.

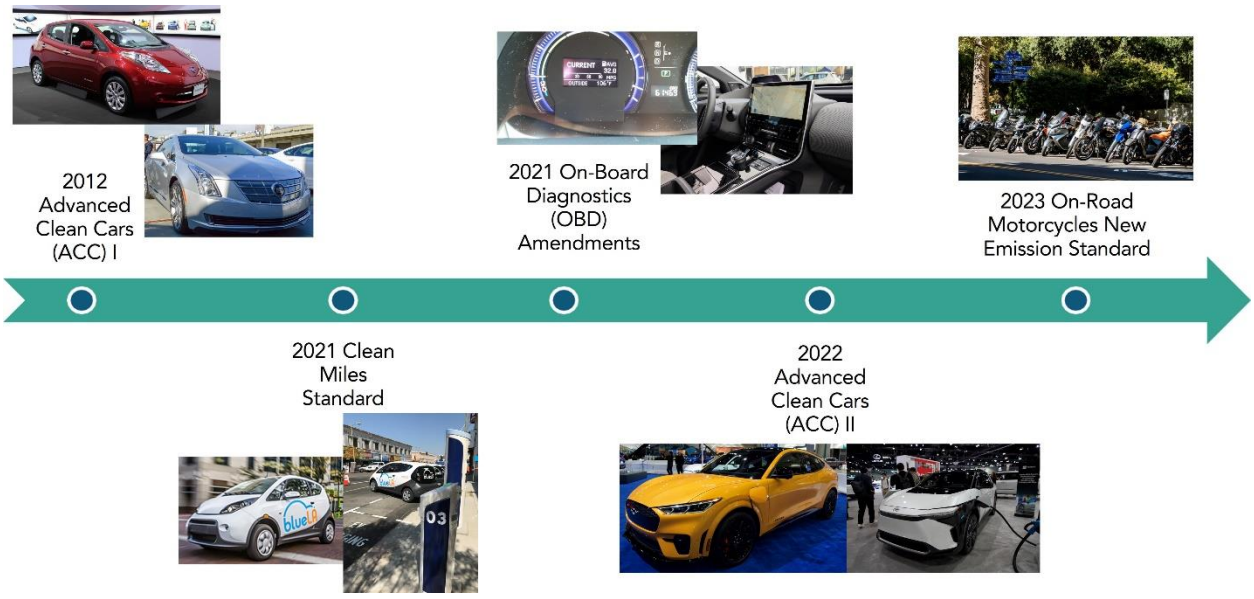
For passenger vehicles, the 2022 State SIP Strategy includes actions to increase the penetration of ZEVs by targeting ride-hailing services offered by transportation network companies through the Clean Miles Standard regulation in order to reduce GHG and criteria pollutant emissions, and promote electrification of the fleet. For motorcycles, the 2022 State SIP Strategy proposes more stringent exhaust and evaporative emissions standards along with zero-emissions sales thresholds. The primary goal of the On-Road Motorcycle New Emissions Standard measure is to reduce emissions from new, on-road motorcycles by adopting more stringent exhaust and evaporative emissions standards along with zero-emissions sales thresholds.

CARB is also active in implementing in-use programs for owners of older dirtier vehicles to retire them early. The "car scrap" programs, like Clean Cars 4 All and Clean Vehicle Rebate Project provide monetary incentives to replace old vehicles with zero-emission vehicles. Other California programs and goals, such as the 2012 Governor's Executive Order to put 1.5 million zero-emission vehicles on the road by 2025 – which was

attained two years early in 2023 – have produced substantial and cost-effective emission reductions from the light-duty vehicle sector.[46]

Taken together, California's emission standards, fuel specifications, and incentive programs for on-road light- and medium-duty vehicles represent all measures that are technologically and economically feasible within California. As a result of these efforts, light-duty vehicle emissions in the South Coast have been reduced significantly since 1990 and will continue to go down through 2030. From today, light-duty vehicle NOx emissions are projected to decrease by nearly 65 percent by 2030.

Figure 3: Light-Duty Control Measures



NEW VEHICLE STANDARDS

Emission Standards and ZEV Requirements

California is the only state with the authority to adopt and enforce emission standards for new motor vehicle engines that differ from the federal emission standards, which enables CARB to develop more stringent motor vehicle control measures than other states. Adopted in 2012, the ***ACC I*** program is a suite of regulations that ensure emission reductions from the State's passenger vehicle fleet. In 2013, U.S. EPA issued a waiver for the ACC I Program.[47]

CARB's ACC I program has in recent years been a major driver of turnover to and zero and near-zero emission vehicles in the light-duty sector, providing significant emission reduction benefits. ACC I brought together three major regulations that were previously separate, combining the control of criteria pollutants and greenhouse gas emissions into

[46] California Office of Governor, April 2023. "California Surpasses 1.5 Million ZEVs Goal Two Years Ahead of Schedule" https://www.gov.ca.gov/2023/04/21/california-surpasses-1-5-million-zevs-goal-two-years-ahead-of-schedule/

[47] U.S. EPA 2013 "California State Motor Vehicle Pollution Control Standards; Advanced Clean Car Program; Final Notice of Decision" Federal Register January 9, 2013 Volume 78, Number 6 pp. 2211 – 2145. https://www.gpo.gov/fdsys/pkg/FR-2013-01-09/pdf/2013-00181.pdf

a single coordinated set of requirements for light-duty vehicles of model years 2015 through 2025.

- Two of these regulations, the ***LEV III GHG*** and ***LEV III Criteria Emission*** rules, are fleet average performance standards for new vehicles that provide for continued annual emission reductions as the stringency increases through 2025. When fully phased-in, these requirements will achieve near-zero emission levels from new light-duty vehicles. These programs apply to the entire light-duty fleet by setting an average emissions requirement across all new vehicles that creates inherent market flexibility for compliance.

- The third regulation, the ***ZEV Regulation***, focuses on advanced technology development and fleet penetration of ZEVs (i.e. battery electric vehicles and hydrogen fuel cell vehicles), and plug-in hybrid electric vehicles (PHEVs) in order to enable manufacturers to successfully meet 2018 and subsequent model year requirements. The ZEV regulation ensures that advanced electric drive technology is commercialized and brought to production scale for cost reductions by 2025, in order to ensure that these low-emission technology vehicles transition from demonstration phase to full commercialization in a reasonable timeframe to meet long-term emission reductions goals. The ZEV amendments for 2018 and subsequent model years in the ACC program are intended to achieve commercialization through simplifying the regulation and pushing technology to higher volume production in order to achieve cost reductions.

The ACC I program has ushered in a new zero emission passenger transportation system. The success of this program is evident: California is the world's largest market for Zero Emission Vehicles (ZEVs), with 119 passenger vehicle models available today, including battery-electric, plug-in hybrid electric, and fuel cell electric vehicles.[48] A wide variety are now available at lower price points, attracting new consumers. In April 2023, the Governor's 2012 target of 1.5 million ZEVs on the road by 2025 was attained two years early, facilitated in part by $2 billion in ZEV incentive funding and rebates that have been distributed to Californians through programs like the Clean Vehicle Rebate Project and Clean Cars 4 All.[49] Approximately 21 percent of all new cars sold in California in 2023 have been ZEVs. Californians, who drive only 10 percent of the nation's cars, account for over 40 percent of all zero-emission car sales in the country. The U.S. makes up about half of the world market. This movement towards commercialization of advanced clean cars has occurred due to CARB's ZEV requirements, part of ACC, which affects passenger cars and light-duty trucks.

In support of California's transition to zero-emission vehicles, in 2020, Governor Newsom signed Executive Order N 79 20,[50] which established a goal that 100 percent of California sales of new passenger cars and trucks be zero-emission by 2035. With this order and many other recent actions, Governor Newsom has recognized that air pollution remains a challenge for California that requires bold action. Zero-emission

[48] VELOZ, February 2023 "Electric Vehicle Market Report, Q4 2022" https://www.veloz.org/ev-market-report/
[49] California Office of Governor, April 2023. "California Surpasses 1.5 Million ZEVs Goal Two Years Ahead of Schedule" https://www.gov.ca.gov/2023/04/21/california-surpasses-1-5-million-zevs-goal-two-years-ahead-of-schedule/
[50] Executive Order N-79-20 https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf

vehicle commercialization in the light-duty sector is well underway. Longer-range battery electric vehicles are coming to market that are cost-competitive with gasoline fueled vehicles and hydrogen fuel cell vehicles are now also seeing significant sales. Autonomous and connected vehicle technologies are being installed on an increasing number of new car models. A growing network of retail hydrogen stations is now available, along with a rapidly growing battery charger network.

Advanced Clean Cars II (ACC II), a measure in the 2016 State SIP Strategy that was adopted by the CARB Board in August 2022, imposes the next level of low-emission and zero-emission vehicle standards for model years 2026-2035 that contribute to meeting federal ambient air quality ozone standards and California's carbon neutrality targets. The ACC II regulations will rapidly scale down emissions of light-duty passenger cars, pickup trucks and SUVs starting with the 2026 model year through 2035. The ACC II regulation also takes the State's already growing zero-emission vehicle market and robust motor vehicle emission control rules and augments them to meet more aggressive tailpipe emissions standards and ramp up to 100 percent zero-emission vehicles by 2035 for all new passenger cars, trucks and SUVs sold in California. ACC II is two-pronged: it will drive the sales of zero emission vehicles (ZEV) and the cleanest-possible plug-in hybrid-electric vehicles (PHEV) to 100-percent in California by the 2035 model year through its ***Zero Emission Vehicle (ZEV) Regulation***, while also reducing smog- and PM-forming emissions from new Internal Combustion Engine Vehicles (ICEVs) through the ***Low Emission Vehicle (LEV) IV Regulation***.

The LEV IV regulation will further increase the stringency of CARB's criteria pollutant emission standards for light- and medium-duty vehicles for MY 2026 – 2035. LEV IV consists of multiple components:

- Prevents potential emission backsliding of ICEVs that is otherwise possible under the existing regulations by applying the exhaust and evaporative emission fleet average standards exclusively to combustion engines. Although the NMOG+NOx fleet average for light-duty vehicles remains at 30 mg/mi for MY 2026-2035, the medium-duty vehicle fleet average declines from 178 mg/mi to 150 mg/mi for Class 2b and from 247 mg/mi to 175 mg/mi for Class 3. Additionally, LEV IV eliminates the composite standard option for SFTP emissions to ensure maximum emissions control on all test cycles.
- For light-duty vehicles, lowers the maximum NMOG+NOx exhaust emission rate from 160 mg/mi in MY 2025 to 70 mg/mi in MY 2029; the US06 PM emission rate from 6 mg/mi to 3 mg/mi; and evaporative running loss emission rates from 0.05 g/mi to 0.01 g/mi. For medium-duty vehicles, lowers the maximum NMOG+NOx exhaust emission rate from 250 mg/mi in MY 2025 to 170 mg/mi in MY 2028 for Class 2b and from 400 mg/mi to 230 mg/mi for Class 3.
- Reduces cold start emissions by applying the emission standards to a broader range of in-use driving conditions. (Starts after the vehicle engine has been shut-off for more than 12 hours are considered cold starts.)
- Medium-duty vehicles with gross combined weight rating above 14,000 lbs. would also be subject to in-use test standards to capture emissions while towing.

CARB will further increase the stringency of sales requirements for ZEVs and PHEVs through the ACC II program's ZEV regulation, which will require manufacturers to deliver for sale increasing percentages of ZEVs and PHEVs as a portion of their overall product deliveries between model years 2026 and 2034 and reach 100-percent ZEVs in 2035 (and after). ACC II also includes innovative charging and ZEV assurance measures, which include ZEV warranty and durability requirements, serviceability, and battery labeling requirements.

Break and Tire Wear

Vehicles emit inhalable particles from two major sources: the exhaust system, which has been extensively characterized and regulated; and non-exhaust sources including brake wear, tire and road wear, clutch wear and road dust resuspension. The non-exhaust sources have not been regulated because they are difficult to measure and control. However, with increasingly stringent standards for exhaust emissions, the non-exhaust fraction has become increasingly important. Model predictions suggest that traffic-related emissions of both $PM_{2.5}$ and PM_{10} will eventually be dominated by non-exhaust sources.

Additionally, there is concern that exposure to these particles may increase in California because proposed regional land use and transportation plans may lead to denser cities and a higher proximity of people to major roadways. Under the ACC program, the regenerative braking of ZEVs and PHEV results in lower PM emissions from brake wear and thus provides non-exhaust PM2.5 emission benefits. As increasing numbers of ZEVs enter the fleet, which are characterized by regenerative braking and lower rolling resistance tires, these technologies offer opportunities to reduce PM2.5 emissions from the passenger vehicle fleet.

Clean Miles Standard

The ***Clean Miles Standard (CMS)*** regulation, which was adopted by CARB in 2021 and will be implemented by the California Public Utilities Commission (CPUC), is a regulation to reduce GHG emissions from ride-hailing services offered by transportation network companies (TNCs), on a per--passenger mile basis, and promote electrification of the fleet by setting an electric vehicle mile target. TNCs provide on-demand rides through a technology--based platform that connects passengers with drivers using personal or rented vehicles.

The CMS includes two annual targets – an eVMT target as well as a GHG target in the metric of g CO2/PMT. The eVMT target would require TNCs to achieve 90 percent eVMT by 2030. The GHG target would require TNCs to achieve 0 g CO2/PMT by 2030 through electrification as well as other strategies, including increasing shared rides on their platform, improving operational efficiency (route planning and reduced mileage without passengers), and obtaining optional GHG credits. Optional GHG credits may be requested by the TNCs and approved by the CPUC for ride-hailing trips that are connected to mass transit through a verified booking process, and for investing in bicycle and sidewalk infrastructure projects that support active transportation.

On-Board Diagnostic (OBD) Systems

OBD systems serve an important role in helping to ensure that engines and vehicles maintain low emissions throughout their full life. OBD systems are designed to identify when a vehicle's emission control systems or other emission-related computer-controlled components are malfunctioning, causing emissions to be elevated above the vehicle manufacturer's specifications. Many states currently use the OBD system as the basis for passing and failing vehicles in their inspection and maintenance programs, as is exemplified by California's Smog Check Program. For light-duty vehicles, all 2000 and newer MY vehicles are inspected by accessing the OBD system to verify that no emission-related faults are present.

California's first ***On Board Diagnostics Regulation (OBD I)*** required manufacturers to monitor some of the emission control components for passenger vehicles, light- and medium- duty vehicles, starting with the 1988 model year. In 1989, CARB adopted ***OBD II***, which required 1996 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines to be equipped with second-generation OBD systems, which standardized the system and addressed the shortcomings of the OBD I requirements (OBD I requirements monitored only a few of the emission-related components on a vehicle). U.S. EPA granted CARB a waiver of preemption for the OBD II regulation in 2016.[51]

The Board has modified the OBD II regulation in regular updates since initial adoption to address manufacturers' implementation concerns and, where needed, to strengthen specific monitoring requirements. Most recently, the Board amended the regulation in 2021 to require manufacturers to implement Unified Diagnostic Services (UDS) for OBD communications, which will provide more information related to emissions-related malfunctions that are detected by OBD systems, improve the usefulness of the generic scan tool to repair vehicles, and provide needed information on in-use monitoring performance. UDS implementation would be required for all 2027 and subsequent model year light- and medium-duty vehicles and engines, as well as some heavy-duty vehicles and engines.

Emissions Standards for Motorcycles

While representing a relatively small fraction of the emissions coming from the passenger vehicle fleet, CARB has also taken a comprehensive control approach for emissions from motorcycles. For the most part, motorcycles are on-road two-wheeled, self-powered vehicles with engine displacements of 50 cubic centimeters (cc) or greater. First adopted in 1975, ***California's On-Road Motorcycle Regulation*** obtained its first waiver of preemption from U.S. EPA in 1976. The 1975 regulation set emission standards for all motorcycles with engine displacements of at least 50 cc. The ***1998 Amendments to the California Motorcycle Regulation*** affected only Class 3 motorcycles (280 cc or greater) and set a Tier I and Tier II standard for 2004 and 2008

[51] U.S. EPA 2016 "California State Motor Vehicle Pollution Control Standards; Malfunction and Diagnostic System Requirements for 2004 and Subsequent Model Year Passenger Cars, Light-Duty Trucks, and Medium-Duty Vehicles and Engines; Final Notice of Decision" https://www.gpo.gov/fdsys/pkg/FR-2016-11-07/pdf/2016-26861.pdf November 7, 2016 Federal Register Volume 81, Number 215 pp. 78143-78149

model years, respectively. While CARB has the same emission standard as the federal standard, the California standard applies to engines starting in 2008 rather than 2010 under the federal requirement. The California Motorcycle Regulation controls both exhaust emission standards and test procedures for on-road motorcycles and motorcycle engines. U.S. EPA granted CARB a waiver of preemption for the 1998 amendments in August 2006.[52] California's motorcycle exhaust emission test procedures are adopted from U.S. EPA's exhaust test procedures (CFR title 40, part 86, subparts E and F).

Since the 1990s, more stringent exhaust emissions standards have been developed by other jurisdictions around the world, most notably the European Union's EU5 standard which became effective in 2020. These stringent exhaust standards have prompted the development of cleaner motorcycles than what are currently required in California. Thus, the 2022 State SIP Strategy includes the ***On-Road Motorcycle New Emission Standard*** measure, CARB's latest commitment to reduce emissions from motorcycles. While CARB's existing motorcycle evaporative standards are on par with most other jurisdictions around the world, additional evaporative reductions are technically feasible and other vehicle categories regulated by CARB have adopted much lower evaporative emissions standards. For example, CARB's Off Highway Recreational Vehicle (OHRV) category, which includes vehicles closely related to motorcycles such as off-highway motorcycles, requires lower evaporative emissions limits with more robust test methods. Since 2017, CARB has been working closely with many other jurisdictions in the spirit of trying to achieve harmonization where possible on lower and more robust motorcycle emissions standards. Specifically, CARB has worked closely with U.S. EPA, Environment Climate Change Canada, the European Union, and the United Nations. California also currently has no inspection and maintenance program for motorcycles. CARB has determined that tampering with emissions controls is a significant problem for this category.

The On-Road Motorcycle New Emissions Standard is anticipated to reduce emissions from new, on-road motorcycles (motorcycles) by adopting more stringent exhaust and evaporative emissions standards along with zero-emissions sales thresholds. The exhaust standards would be more stringent than current U.S. EPA standards and largely harmonized with European Union 5 (EU 5) standards. The evaporative standards would be more stringent than current U.S. EPA and EU 5 standards. This measure will also require an increase in new Zero-Emissions Motorcycle (ZEM) sales, starting at 10 percent in 2028 and progressing to 50 percent in 2035. CARB staff is in the process of developing new exhaust emissions standards for hydrocarbons (HC), NOx, CO and nonmethane HC (NMHC) that achieve a large degree of harmonization with more aggressive current European motorcycle emissions standards. CARB would also develop new evaporative emissions standards that largely harmonize with more aggressive current CARB OHRV emissions standards.

[52] https://www.epa.gov/state-and-local-transportation/vehicle-emissions-california-waivers-and-authorizations See Code of Federal Regulations Volume 71, Number 149 pp. 44027-44029

REDUCING IN-USE EMISSIONS

Inspection and Maintenance (I/M) Program

Although new vehicles sold in California are the cleanest in the world, the millions of passenger vehicles on California roads, and the increasing miles they travel each day make them our single greatest source of NOx emissions. While the new vehicles in California may start out with very low emissions, improper maintenance or faulty components can cause vehicle emission levels to sharply increase. Studies estimate that approximately 50 percent of the total emissions from late-model vehicles are excess emissions, meaning that they are the result of emission-related malfunctions.

California's ***Smog Check Program*** works to ensure that the vehicles remain as clean as possible over their entire life. The Bureau of Automotive Repair (BAR) is the State agency charged with administration and implementation of the Smog Check Program. The Smog Check Program is designed to reduce air pollution from California registered vehicles by requiring periodic inspections for emission-control system problems, and by requiring repairs for any problems found. In 1998, the Enhanced Smog Check program began in which Smog Check stations relied on the BAR-97 Emissions Inspection System (EIS) to test tailpipe emissions with either a Two-Speed Idle (TSI) or Acceleration Simulation Mode (ASM) test depending on where the vehicle was registered. For instance, vehicles registered in urbanized areas received an ASM test, while vehicles in rural areas received a TSI test.

In 2009, the following requirements were added in to improve and enhance the Smog Check Program, making it more inclusive of motor vehicles and effective on smog reductions:

- Low pressure evaporative test;
- More stringent pass/fail cutpoints;
- Visible smoke test; and
- Inspection of light- and medium-duty diesel vehicles.

The next major change in the Smog Check Program was due to AB 2289, adopted in October 2010, a new law restructuring California's Smog Check Program, streamlining and strengthening inspections, increasing penalties for misconduct, and reducing costs to motorists. This new law, supported by CARB and BAR, promised faster and less expensive Smog Check inspections by talking advantage of the second generation of OBD software installed on all vehicles. The new law also directs vehicles without this equipment to high-performing stations, helping to ensure that these cars comply with current emission standards. This program will reduce consumer costs by having stations take advantage of diagnostic software that monitors pollution-reduction components and tailpipe emissions. Beginning mid-2013, testing of passenger vehicles using OBD was required on all vehicles model years 2000 or newer.

In the South Coast, Smog Check requirements are consistent with the most stringent of any other I/M program in the nation. Biennial, change of ownership, and initial

registration Smog Check inspections ensure that the in-use passenger vehicle fleet continues to operate as cleanly as possible. Additionally, a portion of vehicles must receive their biennial Smog Check inspections at STAR certified test only or test/repair stations that are required to meet high inspection-based standards.

Based on recent CARB analysis in support of the Smog Check Performance Standard Modeling and Program Certification for the 70 Parts Per Billion 8-hour Ozone Standard (CARB Board meeting, March 23, 2023), the Smog Check Program meets the federal I/M requirements for all applicable nonattainment areas classified as Moderate or above, including the South Coast, San Joaquin Valley, Coachella Valley, Western Mojave Desert, San Diego County, Sacramento Metro, Eastern Kern, and Ventura County nonattainment areas, and the 75 parts per billion 8-hour ozone standard for the San Diego County and Eastern Kern nonattainment areas.

CARB staff's discovery of Volkswagen's (VW's) use of illegal defeat devices—software designed to cheat on emissions tests—in certain 2009 to 2016 model year diesel cars that were sold in California illustrates the success and stringency of California's program to control emissions from the in-use passenger vehicle fleet, and to identify excess in-use emissions. Due to the discovery of VW's emissions cheating scandal and subsequent actions to remediate the environmental damages caused by these vehicles' excess emissions, the VW Environmental Mitigation Trust provides about $423 million for California to fund projects that accelerate the turnover of mobile sources to cleaner, lower-emitting vehicles and engines.

REDUCING VEHICLE MILES TRAVELLED (VMT)

In addition to the potential measures described above to control emissions from on-road mobile sources, reducing vehicle miles traveled (VMT) is also necessary to directly and immediately reduce mobile source NOx and ROG emissions. CARB works cooperatively with other State agencies, and the local air districts, metropolitan planning organizations (MPOs), and other local entities to implement the Sustainable Communities and Climate Protection Program and related efforts. This involves developing, adopting, and implementing Sustainable Communities Strategies (SCS), which include VMT reduction targets as required under Senate Bill 375. That said, reducing VMT is difficult; many factors influence an individual's travel choices, and these choices interact with one another in a complex manner that is not always well understood. In the 2020 Mobile Source Strategy, CARB identified several strategies that could be undertaken to assist in achieving additional reductions and support implementation of regional SCSs. Building on the strategies identified in the 2020 MSS, in the 2022 State SIP Strategy, CARB committed to the ***Enhanced Regional Emission Analysis in SIPs*** measure, which will reduce VMT from on-road mobile sources through a Transportation Control Measure (TCM), a strategy to reduce emissions or concentration of air pollutants by reducing the number of vehicle trips or VMT or improving traffic flow. This measure was originally proposed as a public measure suggestion, based on the input from community-based organizations and members of

the public. During the development of the 2022 State SIP Strategy, CARB staff developed this public measure suggestion into a SIP measure commitment.

CARB is considering the following measures to further reduce ROG and NOx emissions from on-road motor vehicles by reducing VMT:

- Change MVEB Development Process:
  CARB would evaluate the existing MVEB development process, including tools and the latest planning assumptions used in the analysis. Based on the review, CARB could modify the framework for developing MVEBs when considering how to address gaps in emissions reductions needed to demonstrate attainment of different NAAQS. This framework could explore additional emissions reductions from the on-road sector to attain the 70 ppb 8-hour ozone standard and progress towards State air quality goals. This framework would need to ensure that the MVEB is consistent with other applicable requirements such as emission inventory, reasonable further progress, control measures, and attainment demonstration.
- RACM Analysis:
  CARB would compile a comprehensive list of TCMs implemented or considered by federal, state, regional, and local agencies. This list would provide more choices and new measures subject to RACM analysis for potential inclusion as an enforceable measure in the SIP. This effort may also evaluate the emission reduction potential, feasibility, and cost-effectiveness of each TCM on the list. In addition, CARB could consider providing a quantification methodology to improve and standardize the RACM analysis as part of SIPs across air districts. In pursuing this measure, CARB would work in a collaborative effort with U.S. EPA, California MPOs, and air districts to develop the guidance and implement each potential TCM identified through the RACM.
- Update Guidance for CMAQ and Motor Vehicle Fees:
  CARB would update the methodology and guidelines for estimating the cost-effectiveness of some of the most widely implemented transportation-related air quality projects using CMAQ and motor vehicle fees. Further, these guidelines would establish methods to quantify emission benefits and cost-effectiveness of new available transportation options and technologies. This update may also include critical inputs associated with emissions estimation to streamline the quantification of cost-effectiveness of various transportation projects. This action will accelerate the penetration of new strategies and maximize the emissions reductions from the transportation sector in the near-term. CARB would work with FHWA, the California Department of Transportation, MPOs, and air districts in pursuing this measure.

FUELS

Cleaner fuel has an immediate impact in reducing emissions from the mobile source, and thus represent an important component in reducing NOx and ROG emissions from

the passenger vehicle fleet. California's stringent air quality programs treat motor vehicles and their fuels holistically (as a system, rather than as separate components). As a result, CARB's fuels programs achieve significant reductions in criteria emissions from gasoline-fueled vehicles used in California.

California's Reformulated Gasoline program (CaRFG) sets stringent standards for California gasoline that produced cost-effective emission reductions from gasoline-powered vehicles resulting in California gasoline being the cleanest in the world. California's cleaner-burning gasoline regulation is one of the cornerstones of the State's efforts to reduce air pollution and cancer risk. Reformulated gasoline is fuel that meets specifications and requirements established by CARB. The results from cleaning up fuel can have an immediate impact as soon as it is sold in the State. Vehicle manufacturers design low-emission vehicles to take full advantage of cleaner-burning gasoline properties.

The CaRFG program has been implemented in three phases:

- Phase 1, which was implemented in 1991, eliminated lead from gasoline and set regulations for deposit control additives and reid vapor pressure (RVP).
- Phase 2 CaRFG (CaRFG2 in 1994) set specifications for sulfur, aromatics, oxygen, benzene, T50, T90, Olefins, and RVP and established a Predictive Model.
- The final and current phase, Phase 3 CaRFG, eliminated, in 1996, the use of methyl-tertiary-butyl-ether in California gasoline.

The use of cleaner-burning gasoline in the South Coast has been required since March 1996. ***Phase 3 CaRFG*** also revised specifications for Phase 3 gasoline that reduces ozone precursor emissions (including aromatic hydrocarbons and olefins) by ~15 percent and toxic air contaminant emissions by about 40 percent, compared with CaRFG2. The regulation strengthened specification requirements for cleaner-burning gasoline, including:

- Reduced sulfur content. Sulfur inhibits the effectiveness of catalytic converters. Cleaner-burning gasoline enables catalytic converters to work more effectively and further reduce tailpipe emissions.
- Reduced benzene content. Benzene is known to cause cancer in humans. Cleaner-burning gasoline has about one-half the benzene of earlier gasoline, thus reducing cancer risks.
- Reduced levels of aromatic hydrocarbons (ozone precursor).
- Reduced levels of olefins (ozone precursor).
- Reduced reid vapor pressure, which ensures that gasoline evaporates less readily.
- Two specifications for reduced distillation temperatures, which ensure the gasoline burns more completely, and
- Use of an oxygen-containing additive, such ethanol, which also helps the gasoline burn more cleanly.

STEP 2(B): OTHER STATES' AND NONATTAINMENT AREAS' LIGHT-DUTY CONTROL MEASURES

Table 7 summarizes the most stringent control measures currently in use in any state or nonattainment that have been identified and discussed for on-road light-duty vehicles. Each of the measures identified in this table are discussed in more detail in this section, below.

Table 7: Comparison of Stringency – Light-Duty Measures

CARB Control Programs Compared to Federal Standards and Control Programs in Other States and Nonattainment Areas

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Light-Duty Vehicles			
New Vehicle Standards			
New Vehicle Standards: Emissions standards (passenger cars)	LEV III program (CARB) MY 2015 - 2025 (part of Advanced Clean Cars I program) LEV IV program (CARB) MY 2026 - 2035 (part of Advanced Clean Cars II program)	17 states have adopted California's Low Emission Vehicle III (LEV III) program, which set fleet average criteria pollutant performance standards for new light- and medium-duty vehicles for MY 2015 - 2025 CARB will further increase the stringency of CARB's criteria pollutant emission standards with LEV IV program, a part of ACC II, for MY 2026 – 2035. LEV IV consists of these components: • Prevents potential emission backsliding of ICEVs that is otherwise possible under the existing regulations by applying the exhaust and evaporative emission fleet average standards exclusively to combustion engines. Although the NMOG+NOx fleet average for light-duty vehicles remains at 30 mg/mi for MY 2026-2035, the medium-duty vehicle fleet average declines from 178 mg/mi to 150 mg/mi for Class 2b and from 247 mg/mi to 175 mg/mi for Class 3. Additionally, LEV IV eliminates the composite standard option for SFTP emissions to ensure maximum emissions control on all test cycles. • For light-duty vehicles, lowers the maximum NMOG+NOx exhaust emission rate from 160 mg/mi in MY 2025 to 70 mg/mi in MY 2029; the US06 PM emission rate from 6 mg/mi to 3 mg/mi; and evaporative running loss emission rates from 0.05 g/mi to 0.01 g/mi. For medium-duty vehicles, lower the maximum NMOG+NOx exhaust emission rate from 250 mg/mi in MY 2025 to 170 mg/mi in MY 2028 for Class 2b and from 400 mg/mi to 230 mg/mi for Class 3. • Reduces cold start emissions by applying the emission standards to a broader range of in-use driving conditions. (Starts after the vehicle engine has been shut-off for more than 12 hours are considered cold starts.) • Medium-duty vehicles with gross combined weight rating above 14,000 lbs. would also be subject to in-use test standards to capture emissions while towing.	17 States have adopted the LEV III requirements of ACC I under the provisions of Section 177: • NY, MA, VT, ME, PA, CT, RI, WA, OR, NJ, MD, DE, CO, MN, NV, VA, and NM LEV IV regulations will control emissions of criteria pollutants from the exhaust and fuel systems of conventional motor vehicles. They would apply to vehicles produced and delivered for sale in California beginning with the 2026 model year. They are more stringent than the existing federal Tier 3 standards for the same pollutants from motor vehicles for the 2025 and subsequent model years that were set by the U.S. EPA. Five other states have adopted the new LEV IV from ACC2 under Section 177: MA, OR, WA, VT, and NY
New Vehicle Standards:	ZEV program (CARB) MY 2015 - 2025 (part of Advanced Clean Cars I program)	15 states have matched California's current ZEV Regulation for battery electric vehicles (BEVs), hydrogen fuel cell vehicles (FCEVs), and plug-in hybrid electric vehicles (PHEVs).	15 states have adopted the ZEV requirements of ACC I under the provisions of Section 177:

CARB Control Program MSM Analysis
for the SCAQMD 2024 12 µg/m^3 annual PM2.5 Plan

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Light-Duty Vehicles			
Zero-emission Requirements (passenger cars)	ACC II's ZEV Program (CARB) MY 2026 – 2035 (part of Advanced Clean Cars II program)	CARB will further increase the stringency of sales requirements for ZEVs and PHEVs through the ACC II program's ZEV regulation, which will require manufacturers to deliver for sale increasing percentages of ZEVs and PHEVs as a portion of their overall product deliveries between model years 2026 and 2034 and reach 100-percent ZEVs in 2035 (and after). ACC II also includes innovative charging and ZEV assurance measures, which include ZEV warranty and durability requirements, serviceability, and battery labeling requirements	• NY, MA, VT, ME, CT, RI, WA, OR, NJ, MD, CO, MN, NV, VA, and NM Five other states have adopted the new ZEV standards from ACC2 under Section 177: MA, OR, WA, VT, and NY There are no comparable federal standards for sales of zero-emission vehicles.
New Vehicle Standards: On-Board Diagnostic (OBD) systems requirements	California OBD II Requirements (CARB)	CARB's On-Board Diagnostic II (OBD II) Systems Requirements exceed Federal requirements in stringency. OBD II ensures that the in-use fleet continues to operate as cleanly as possible.	In practice, virtually all vehicles sold in the U.S. are designed and certified to meet California's OBD II requirements, regardless of where in the U.S. they are sold.
New Vehicle Standards: Emissions standards (Motorcycles)	California's On-Road Motorcycle Regulation (CARB) Future Measure: *On-Road Motorcycle New Emissions Standards (CARB)*	CARB's emission standards and in-use testing for on-road motorcycles (California's On-Road Motorcycle Regulation) set a Tier I and Tier II standard for 2004 and 2008 model years, respectively, for Class 3 motorcycles (280 cc or greater). California's evaporative emission limits for motorcycles exceed the stringency of any other in the nation, while exhaust emission a limits and test procedures are consistent with U.S. EPA's. The 2022 State SIP Strategy committed to the On-Road Motorcycle New Emission Standard, which will further reduce emissions from new-on-road motorcycles through the adoption of more stringent exhaust and evaporative emissions standards along with zero-emissions sales thresholds. The exhaust standards would be more stringent than current U.S. EPA standards and largely harmonized with European Union 5 (EU 5) standards. The evaporative standards would be more stringent than current U.S. EPA and EU 5 standards. This measure will also require an increase in new Zero-Emissions Motorcycle (ZEM) sales, starting at 10 percent in 2028 and progressing to 50 percent in 2035. *(Note: CARB has committed to pursue the On-Road Motorcycle New Emissions Standard measure, but this measure has yet to be proposed to the Board for approval/adoption)*	California is the only state with emission control requirements for on-road motorcycles that exceed the stringency of U.S. EPA requirements.
In-Use Emission Controls			
In-Use Emission Controls: Inspection and maintenance program (I/M program)	Smog Check Program (CARB and administered by the California Department of Consumer Affairs' Bureau of Automotive Repair)	The Inspection / Maintenance (I/M) Program testing and in-use emission controls in the South Coast are consistent with the most stringent of any other I/M program in the nation. Biennial, change of ownership, and initial registration Smog Check inspections ensure that the in-use passenger vehicle fleet continues to operate as cleanly as possible. Additionally, a portion of vehicles must receive their biennial Smog Check inspections at STAR certified test only or test/repair stations that are required to meet high inspection-based standards.	32 states and areas have an I/M program in at least a portion of their state or area (AZ, CO, CA, CT, DE, GA, ID, IL, IN, LA, ME, MD, MA, MO, NV, NH, NJ, NM, NC, NY, OH, OR, PA, RI, UT, TN, TX, VA, VT, WA, WI, and DC).

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Light-Duty Vehicles			
		Based on recent CARB analysis in support of the Smog Check Performance Standard Modeling and Program Certification for the 70 Parts Per Billion 8-hour Ozone Standard (CARB Board meeting, March 23, 2023), the Smog Check Program meets the federal I/M requirements for all applicable nonattainment areas classified as moderate or above, including the South Coast Air Basin, San Joaquin Valley, Coachella Valley, Western Mojave Desert, San Diego County, Sacramento Metro, Eastern Kern, and Ventura County nonattainment areas, and the 75 parts per billion 8-hour ozone standard for the San Diego County and Eastern Kern nonattainment areas.	
In-Use Emission Controls: Fleet Rules	Clean Miles Standard (CARB)	The Clean Miles Standard (CMS) regulation, which was adopted by CARB in 2021, is to reduce GHG emissions from ride-hailing services offered by transportation network companies (TNCs), on a per--passenger mile basis, and promote electrification of the fleet by setting an electric vehicle mile target. TNCs provide on-demand rides through a technology--based platform that connects passengers with drivers using personal or rented vehicles. The CMS includes two annual targets – an eVMT target as well as a GHG target in the metric of g CO2/PMT. The eVMT target would require TNCs to achieve 90 percent eVMT by 2030. The GHG target would require TNCs to achieve 0 g CO2/PMT by 2030 through electrification as well as other strategies, including increasing shared rides on their platform, improving operational efficiency (route planning and reduced mileage without passengers), and obtaining optional GHG credits. Optional GHG credits may be requested by the TNCs and approved by the CPUC for ride-hailing trips that are connected to mass transit through a verified booking process, and for investing in bicycle and sidewalk infrastructure projects that support active transportation.	CARB staff is unaware of any other state or jurisdiction with VMT reduction programs via Transportation Network Companies (TNCs).
In-Use Emission Controls: Transportation Control Measure (TCM) Reducing Vehicle Miles Travelled (VMT)	Future Measure: *Enhanced Regional Emission Analysis in SIPs (CARB)*	CARB is considering the following measures to further reduce ROG and NOx emissions from on-road motor vehicles by reducing VMT: • Change MVEB Development Process: CARB would evaluate the existing MVEB development process, including tools and the latest planning assumptions used in the analysis. Based on the review, CARB could modify the framework for developing MVEBs when considering how to address gaps in emissions reductions needed to demonstrate attainment of different NAAQS. • RACM Analysis: CARB would compile a comprehensive list of TCMs implemented or considered by federal, state, regional, and local agencies to provide more choices and new measures for potential inclusion as an enforceable measure in the SIP. This effort may also evaluate the emission reduction potential, feasibility, and cost-effectiveness of each TCM on the list, and/or provide a quantification methodology to improve and standardize the RACM analysis as part of SIPs across air districts. • Update Guidance for CMAQ and Motor Vehicle Fees: CARB would update the methodology and guidelines for estimating the cost-effectiveness of some of the most widely implemented transportation-related air quality projects using CMAQ and motor vehicle fees. Further, these guidelines would establish methods to quantify	CARB staff is unaware of any other state or jurisdiction that is reducing VMT through similar programs.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Light-Duty Vehicles			
		emission benefits and cost-effectiveness of new available transportation options and technologies. This update may also include critical inputs associated with emissions estimation to streamline the quantification of cost-effectiveness of various transportation projects. *(Note: CARB has committed to pursue the Enhanced Regional Emission Analysis in SIPs measure, but this measure has yet to finalized)*	
Fuel Controls			
Gasoline Standards	CaRFG Phase 3 (CARB)	The CaRFG Phase III program requires that California gasoline is the lowest-emitting and cleanest-burning in the nation. It includes more stringent requirements for emission controls than the applicable federal standard (U.S. EPA's RFG Phase II). Relative to federal gasoline, CARB's reformulated gasoline program reduces NOx emissions by 15 percent and TACs by 50 percent.	U.S. EPA RFG Phase II is currently required in nonattainment areas in 17 states and the District of Columbia (including the South Coast) • Areas of CA, CT, DE, the District of Columbia, IL, IN, MD, NJ, NY, PA, TX, VA, WI Other "opt in" areas for Federal RFG Phase II • Entire states: CT and DE • Portions of states: IL, KT, MD, ME, MA, MS, NH, NJ, NY, RI, TX, VA

NEW VEHICLE STANDARDS

Emission standards and ZEV Regulation

CARB's new vehicle standards for on-road light-duty vehicles are consistent with the most stringent of any other area in the nation. Due to constraints in the Act, California is the only state that can set new vehicle standards (including control measures such as emission standards, ZEV sales mandates, warranty provisions, and on-board diagnostic (OBD) requirements) that are more stringent than U.S. EPA's national standards. Other states can adopt California programs for which U.S. EPA has provided California with waivers.[53] These states are also known as the "Section 177 States" in reference to this provision of the Act. The ability to set more stringent controls than U.S. EPA, however is unique to California, and thus ensures that the California control measures for new vehicle and engine standards are at least equal in stringency to the most stringent controls in the nation.

As a result of CARB's efforts, and as provided for in the Act, other states have now adopted elements of CARB's ACC I program, including seventeen states that have adopted the equivalent of CARB's LEV III program, and fifteen states that have adopted the equivalent of CARB's ZEV program, as listed below in Table 8.

[53] The Clean Air Act allows other states to adopt California's on- and off-road vehicle or engine emission standards under section 209 of the Clean Air Act. Section 209 requires, among other things, that such standards be identical to the California standards for which a waiver or authorization has been granted. States are not required to seek U.S. EPA approval to adopt standards identical to the California standards that have received a waiver or authorization.

Table 8: ACC I Section 177 States: LD Emission Standards and ZEV Regulation

Section 177 States	2012 ZEV (MY 2015 – 2025)	2012 LEVIII (MY 2015 – 2025)
Colorado	X	X
Connecticut	X	X
Delaware		X
Maine	X	X
Maryland	X	X
Massachusetts	X	X
Minnesota	X	X
Nevada	X	X
New Jersey	X	X
New Mexico	X	X
New York	X	X
Oregon	X	X
Pennsylvania		X
Rhode Island	X	X
Washington	X	X
Vermont	X	X

Additionally, five other states have adopted the requirements of ACC II, including the LEV IV and ZEV requirements: Massachusetts, Oregon, Washington, Vermont, and New York.

On-Board Diagnostics (OBD) Requirements

California's OBD requirements for on-road light-duty vehicles are consistent with the most stringent of any other area in the nation. CARB's OBD II program requires that all 1996 and newer model year gasoline and alternate fuel passenger cars and trucks are required to be equipped from the factory with an OBD II system. All 1997 and newer model year diesel fueled passenger cars and trucks are required to meet the OBD II requirements.

U.S. EPA also requires all 1996 and newer model year passenger cars and trucks sold in any state to meet the U.S. EPA OBD requirements.[54] While U.S. EPA's OBD requirements differ slightly from California's OBD II requirements, virtually all vehicles sold in the U.S. are designed and certified to meet the more stringent California's OBD II requirements, regardless of where in the U.S. they are sold.[55] U.S. EPA issued a waiver for California's OBD II program in November 2016, indicating that the California OBD II system requirements are at least as protective of public health as U.S. EPA's OBD requirements.[56]

[54] CARB 2015 "On-Board Diagnostic II (OBD II) Systems - Fact Sheet / FAQs" https://www.arb.ca.gov/msprog/obdprog/obdfaq.htm
[55] CARB 2009 https://www.arb.ca.gov/msprog/smogcheck/march09/transitioning_to_obd_only_im.pdf
[56] U.S. EPA 2016 "California State Motor Vehicle Pollution Control Standards; Malfunction and Diagnostic System Requirements and Enforcement for 2004 and Subsequent Model Year Passenger Cars, Light Duty Trucks, and Medium Duty Vehicles and Engines; Notice of Decision" https://www.gpo.gov/fdsys/pkg/FR-2016-11-07/pdf/2016-26861.pdf Federal Register Vol. 81, No. 215 pp. 78143

Motorcycle emission standards and in-use emissions testing

CARB's emission standards and in-use testing for on-road motorcycles exceeds the stringency of any other in the nation. CARB's emission standards and in-use testing for on-road motorcycles (California's On-Road Motorcycle Regulation) set a Tier I and Tier II standard for 2004 and 2008 model years, respectively, for Class 3 motorcycles (280 cc or greater). California's evaporative emission limits for motorcycles exceed the stringency of any other in the nation, while exhaust emission a limits and test procedures are consistent with U.S. EPA's.

The 2022 State SIP Strategy committed to the On-Road Motorcycle New Emission Standard measure, which will further reduce emissions from new-on-road motorcycles through the adoption of more stringent exhaust and evaporative emissions standards along with zero-emissions sales thresholds. The exhaust standards would be more stringent than current U.S. EPA standards and largely harmonized with the EU 5 standards. The evaporative standards would be more stringent than current U.S. EPA and EU 5 standards. This measure will also require an increase in new Zero-Emissions Motorcycle sales, starting at 10 percent in 2028 and progressing to 50 percent in 2035.

California is the only state with emission control requirements for on-road motorcycles that exceed the stringency of U.S. EPA requirements.

REDUCING IN-USE EMISSIONS

The I/M Program testing and in-use emission controls in the South Coast are consistent with the most stringent of any other I/M program in the nation. California's Smog Check Program is designed to reduce air pollution from California-registered passenger vehicles by requiring periodic inspections for emission control system problems, and by requiring repairs for any problems found. In California, technicians are required to perform an OBD II check (visual and functional) during the Smog Check inspection. On board, self-diagnostic equipment monitors a passenger vehicle's control components to ensure they are functioning correctly. Specifically, the technician visually checks to make sure the warning light is functional, and then the Smog Check test equipment communicates with the on-board computer for fault information. If a fault is currently causing the light to be on, the malfunctioning component must be repaired in order to pass the inspection.

- Stringency and Frequency of I/M Program

  The I/M Program testing and in-use emission controls in the South Coast are consistent with the most stringent of any other I/M program in the nation. Biennial, change of ownership, and initial registration Smog Check inspections ensure that the in-use passenger vehicle fleet continues to operate as cleanly as possible. This is as frequent as Smog Check requirements as any other part of California and is consistent with the most stringent of any other area in the nation, and is the same frequency as the other Extreme nonattainment area for ozone in the country, the San Joaquin Valley and the Coachella Valley. Additionally, a portion of vehicles must receive their biennial Smog Check inspections at STAR certified test only or test/repair stations that are required to

meet high inspection-based standards.

Thirty-two other states and local areas have an I/M program in at least a portion of their state that is also consistent with the federal I/M program.

- Effectiveness of Inspection and Testing Methodology

  Nearly every state besides California that has an I/M program currently relies exclusively on vehicle OBD II system inspections as the basis for its emission inspections of 1996 and newer vehicles.[57] Only California and Colorado still use tailpipe testing: Colorado relies on tailpipe testing exclusively; California's Smog Check Program currently includes two overlapping inspection procedures. Under California's Smog Check program, each 1996 and newer model year vehicles vehicle is subjected to a tailpipe emission test, and also to an inspection of its OBD II system, which independently monitors the performance of the vehicle's emission control systems and related components during everyday driving.

  U.S. EPA acknowledges the viability of OBD II inspections by providing full emission credits to state I/M programs that are based on OBD II only inspections. While U.S. EPA and CARB have generally found that OBD II systems are more effective in detecting emission-related malfunctions on in-use vehicles compared to existing tailpipe testing procedures, the Smog Check Program utilizes both approaches – erring on the side of increased stringency – to ensure each vehicle passes both tests.[58]

  Furthermore, to ensure that California's Smog Check Program remains as effective as possible, CARB has committed in the 2016 State SIP Strategy to work with BAR staff to perform a joint agency, comprehensive evaluation of California's in use performance focused inspection procedures and, if necessary, make improvements to increase the Smog Check Program's effectiveness. CARB will conduct a study to further evaluate California's in-use performance inspection procedures through analysis of the Smog Check database and vehicle sampling obtained through BAR's Random Roadside Inspection Program. This will, as necessary: inform improvements in inspection test procedures; address program fraud; improve the effectiveness and durability of emission related repair work; and improve the regulations governing the design of in-use performance systems on motor vehicles.

FUELS

U.S. EPA administers federal RFG regulations requiring that gasoline sold in various areas of the country with poor air quality meet standards for federal reformulated gasoline. Most gasoline sold in California is subject to the federal RFG standards as well as having to meet the CaRFG standards. All diesel fuel sold in California is subject to both California and federal standards. These standards work complimentarily.

[57] CARB 2009 https://www.arb.ca.gov/msprog/smogcheck/march09/transitioning_to_obd_only_im.pdf
[58] California's Smog Check data indicates that vehicles are more than twice as likely to fail an OBD II-based inspection than the required tailpipe emissions test. CARB 2009 https://www.arb.ca.gov/msprog/smogcheck/march09/transitioning_to_obd_only_im.pdf

Since 1995, U.S. EPA has required federal RFG to be used in the worst-polluted areas in the nation – including the South Coast and other California nonattainment areas (Federal RFG Phase I 1995 requirements). Effective in 2000, U.S. EPA increased the stringency of the federal RFG requirements under the RFG II program. In 2014, U.S. EPA adopted its most recent amendments, Tier 3 Fuel standards, which require lower sulfur content in gasoline to a maximum of 10 ppm beginning in 2017 on an annual average basis, and lower Reid Vapor Pressure to zero, reducing fuel vapor emissions to near zero levels. The program also reduces PM emissions by approximately 70 percent, and NOx and VOCs emissions by approximately 80 percent, relative to the former federal Phase II levels (which were set in 1995). Sulfur content in gasoline is reduced from 30 parts per million (ppm) to 10 ppm on average.

In aggregate, the Tier 3 RFG requirements bring federal gasoline fuel controls in line with those already in place in California. However, CARB's gasoline specifications under the CaRFG requirements are still more stringent than the federal program. CARB significantly controls NOx emissions under requirements in CaRFG Phase 3 that are not mirrored by comparably stringent controls on NOx emissions under the federal RFG Phase 3 requirements. Relative to federal gasoline, CARB's reformulated gasoline program reduces NOx emissions by 15 percent and TACs by 50 percent. Additionally, CARB requires sulfur contents to be capped at 10 ppm, rather than an annual average of 10 ppm as required federally.

Beyond the Federal requirements described above, the Act also allows states to adopt unique fuel programs to meet local air quality needs, which are referred to as Boutique Fuel Programs. Most of these programs set lower gasoline volatility requirements than the federal standards, and most are effective for only part of the year. As of January 19, 2017, U.S. EPA provided as snapshot of these programs that had been approved in SIPs,[59] which are listed below in Table 9 below. Table 9 also compares the stringency of the boutique fuel requirements in these areas to CARB's CaRFG Phase 3. This comparison shows that the CaRFG Phase 3 program requires that California gasoline is the lowest-emitting and cleanest-burning in the nation.

[59] U.S. EPA, 2017 https://19january2017snapshot.epa.gov/gasoline-standards/state-fuels_.html

Table 9: Boutique Gasoline Fuel Programs in the U.S.

Type of Fuel Control	State	Comparison to CaRFG Phase 3
Reid Vapor Pressure (RVP) of 7.8 psi	PA and IN (year-round) TX (May 1 – Oct 1)	CaRFG Phase III sets flat limits of RVP of 7.0 psi (oxygenated fuels) and 6.9 psi (non-oxygenated fuels)
RVP of 7.0 psi	KS, MI, MO, TX	CaRFG Phase III sets flat limits of RVP of 7.0 psi (oxygenated fuels) and 6.9 psi (non-oxygenated fuels)
Cleaner Burning Gasoline (Summer)	AZ	As of 2005, AZ requires CARB's CaRFG Phase III in certain areas
Cleaner Burning Gasoline (non-Summer)	AZ	As of 2005, AZ requires CARB's CaRFG Phase III in certain areas
Winter Gasoline (aromatics & sulfur)	NV	In 1999, Clark County (Las Vegas) adopted California sulfur and aromatics limits

STEP 3(A): EVALUATION OF STRINGENCY: LIGHT-DUTY CONTROL MEASURES

Step 3(a) calls for an evaluation of each of the potential control measures identified in Step 2, in order to evaluate their stringency and determine whether they meet all applicable requirements to satisfy the definitions of MSM as discussed in Section 1 and Section 2.

As shown in Table 7 in Step 2(b), CARB's light-duty control measures are the most stringent in the nation. This comparison between CARB's control measures and the measures currently in place at the federal level and/or within other states and jurisdictions illustrates the stringency of the CARB on-road light-duty vehicle control program, which meets the stringency requirements of MSM.

Furthermore, CARB staff have conducted an analysis of the timing of the mobile source control measures committed to in the 2022 State SIP Strategy, which go beyond the stringency of the current control program as it is now being implemented. Many of these measures are still in their development phases and are not yet being implemented; the development timeline, however, is critical to allowing industry and technological advancements to progress sufficiently such that the newly emerging technologies called for in these regulatory actions (most of which are technology-inducing regulations) have sufficient time to attain market readiness. Table 10, below, discusses the timeframe considerations for each of the applicable light-duty control measures, and indicates why a more expedited timeframe is neither technologically nor economically feasible. For these reasons, the measures meet the MSM requirement of being phased in as "expeditiously as practicable".

Table 10: Light-Duty Control Measures Stringency and Timeline for Implementation

Measures	Implementation Begins	12 ug/m3 Annual PM2.5 Standard (2012)
New Passenger Vehicle Standards		
Advanced Clean Cars (ACC) (Includes both LEV III and ZEV Program)	ongoing	MSM
Advanced Clean Cars 2 (ACC 2) (Includes both LEV IV and Amendments to the ZEV Program)	2026	MSM
Recently amended in 2022 to require that new vehicle sales are 100% ZEV by 2035, the ACC program requires increasingly stringent standards for gasoline cars and passenger trucks. The currently adopted standards and requirements, including the zero-emission requirements of ACC 1 and ACC 2, are technology-forcing and are the most stringent in the nation; further stringency would not be feasible. An accelerated timeline would also not be feasible as new car standards need years of lead time to be developed, certified, manufactured, and implemented.		
In-Use Emission Control Measures		
On-Board Diagnostics II (OBD II)	ongoing	MSM
Recently amended in 2021 to require program updates that address cold start emissions and diesel PM monitoring, many of the regulatory changes to OBD II are phased-in through 2027 to allow sufficient lead time for the necessary technological development, manufacturing, testing, certification, and implementation for the requisite hardware and software changes; accelerated timelines would not be feasible. OBD II requirements are the most stringent in the nation; further stringency would not be feasible.		
Smog Check	ongoing	MSM
Amended in 2010 to enhance program efficacy with new technologies and test methods. California Smog Check requirements are the most stringent passenger vehicle inspection and maintenance in the nation; further stringency would not be feasible.		
Control Measures to Reduce Vehicle Miles Traveled (VMT)		
Clean Miles Standard (2022 State SIP Strategy measure, adopted in 2021)	2023	MSM
Recently adopted in 2021 to set eVMT and GHG requirements for transportation network companies (TNCs). The Clean Miles Standard's zero-emissions technology requirements are the most stringent standard in the nation; further stringency would not be feasible. An accelerated timeline would also not be feasible as standards and fleet requirements need lead time to be implemented.		
Motorcycle Control Measures		
California On-Road Motorcycle Regulation	ongoing	MSM
On-Road Motorcycle New Emission Standards (2022 State SIP Strategy measure with commitment)	2025	MSM
Proposed amendments to California's on-road motorcycle program would require more stringent exhaust emissions standards that would harmonize with European standards, with a Board hearing date anticipated in 2023. Amendments may also include evaporative emissions standards and ZEM sales thresholds. With these amendments, the stringency of CARB's motorcycle program will exceed the stringency of any other U.S. jurisdiction, and will rely on recent developments in emission control technologies; further stringency would not be feasible. Accelerated timelines would also not be feasible as new standards need years of lead time for staff to evaluate feasibility, and for compliant motorcycle technologies to be developed, certified, and implemented.		
Fuels Control Measures		
California's Reformulated Gasoline (CaRFG) Phase III	ongoing	MSM
Amended in 2003 to require the removal of MTBE, and to included refinery limits and cap limits. CARB's gasoline standards and requirements are the most stringent in the world; it is not feasible to require further stringency of fuel specifications.		

STEP 3(B): EVALUATION OF FEASIBILITY: LIGHT-DUTY CONTROL MEASURES

Step 3(b) calls for an assessment of the feasibility of implementing any measure that is not included in the proposed South Coast SIP, but which is identified as a potential MSM control measure in Step 2. During the public process for the 2022 State SIP Strategy, CARB staff received public measure suggestions for additional potential light-duty measures, as described below:

- Light-Duty Vehicle Fleet Regulation
  This measure would involve CARB developing a regulation to implement fleet requirements for public and rental passenger vehicle fleets. This could take the form similar to the recently adopted Clean Miles Standard, which requires an increasing number of electric miles service for ride hailing platforms, or it could take the form of a more traditional fleet rule that mandates the purchase of ZEVs. CARB has a suite of regulations in place to control emissions from light-duty vehicles, and continues to pursue new regulatory actions, in addition to incentives and other complementary programs that can help to accelerate emissions reductions. One such action is the recently adopted Advanced Clean Cars II program, which sets manufacturer sales requirements and continues to drive introduction of ZEVs into the light-duty fleet. Even so, additional fleet average requirements could potentially support a faster rate of transition to zero-emissions, especially in public and private passenger vehicle fleets, which are particularly suited for electrification.

  CARB staff is continuing to explore this suggested measure. CARB staff anticipate that the recently adopted ***Advanced Clean Cars II regulation***, along with existing CARB regulations and current State incentive programs, achieve a significant amount of the benefits that this suggested measure would accomplish. For this reason, it was not included as a measure in the 2022 State SIP Strategy.

- Enhanced Bureau of Automotive Repair Consumer Assistance Program
  This measure would involve CARB working with BAR to enhance the Consumer Assistance Program by expanding the eligibility threshold and/or amounts of funding offered for consumers towards repair assistance and vehicle replacement options. BAR has in place a Consumer Assistance Program[60] to offer eligible low-income consumers repair assistance and vehicle retirement options to help reduce emissions and improve air quality. The repair assistance program currently offers up to $1,200 for emissions-related repairs which correct problems contributing to a vehicle's failure to pass a Smog Check inspection. The vehicle retirement option currently offers income-eligible consumers $1,500 to retire their vehicle.

  CARB staff is continuing to explore this suggested measure and how it can meet the Act requirements for SIP measure approvability. For this reason, it is not included as a measure in the 2022 State SIP Strategy. Nonetheless, the recently

[60] Bureau of Automotive Repair (BAR) Consumer Assistance Program https://www.bar.ca.gov/consumer/consumer-assistance-program

adopted ***Advanced Clean Cars II regulation***, along with existing CARB regulations and current State incentive programs such as the ***Clean Cars 4 All Program***, achieve a significant amount of the benefits that this suggested measure would accomplish. Furthermore, the Clean Cars 4 All Program is under development for statewide expansion and will continue to focus on supporting the lowest income and disadvantaged communities.

- Enhanced Transportation Choices
  This suggested measure or measures would have CARB work with State and local transportation planning organizations, local governments, and communities to advance VMT reductions via enhanced choice. As the bulk of mobile source emissions come from existing vehicles, measures that provide Californians with additional choices as alternatives to using their personal vehicles, e.g. walking, biking, taking public transit, and/or adopting other transportation modes, at least some of the time, can significantly reduce emissions.

  Control measures for consideration could include, but are not limited to, travel demand management programs, incentive programs that fund enhanced transportation planning, or zoning changes that encourage dense, walkable, infill development. CARB staff is continuing to explore this suggested measure and how it can meet the Clean Air Act requirements for SIP measure approvability. For this reason, a SIP measure incorporating this suggestion was not integrated into the 2022 State SIP Strategy. Nonetheless, CARB is pursuing VMT reductions via other approaches, including through the ***Enhanced Regional Emission Analysis in State Implementation Plans measure***, which was committed to in the 2022 State SIP Strategy.

CARB staff continue to investigate the feasibility and potential emission reductions of these public measure suggestions, as well as whether they would meet the U.S. EPA's approvability criteria for SIP measures. Due to feasibility and approvability issues, these suggestions have not yet been formally developed into SIP control measures.

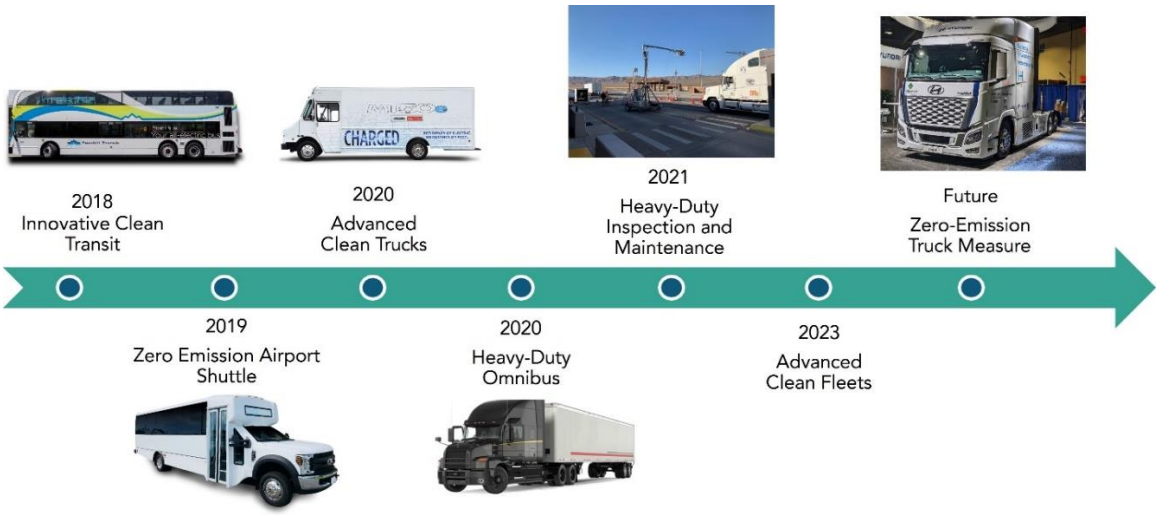
On-Road Medium- and Heavy-Duty Vehicles

On-road heavy-duty vehicles include buses and trucks over 8,500 pounds gross vehicle weight rate (GVWR), and include heavier pick-up trucks and walk-in vans, as well as a wide range of vocational and drayage trucks (big-rig trucks) and buses. These vehicles are one of the fastest growing transportation sectors in the United States, responsible for about 32 percent of total statewide NOx emissions, and are a significant source of statewide diesel PM and GHG emissions. The majority of these vehicles operate on diesel-cycle engines, especially in the higher weight classes. Gasoline and natural gas Otto-cycle spark-ignited engines are also used in heavy-duty trucks, to a lesser extent, and primarily in the lower weight classifications.

STEP 2(A): CALIFORNIA'S MEDIUM- AND HEAVY-DUTY CONTROL MEASURES

Through ongoing efforts, CARB has developed the most stringent and successful heavy-duty vehicle emission control program in the world. CARB has numerous programs currently in place to control emissions from medium- and heavy-duty vehicles including the Truck and Bus Regulation, Heavy-Duty Omnibus, Advanced Clean Trucks, as well as incentive programs such as the widely successful Carl Moyer Program. In addition, CARB recently adopted the Heavy-Duty Inspection and Maintenance regulation, a 2016 State SIP Strategy measure. Regulatory programs include requirements for increasingly tighter new engine standards, address vehicle idling, certification procedures, on-board diagnostics, emission control device verification, and requires accelerated turnover of the in-use fleet to cleaner, lower-emitting emission control and engine technologies. Due to the benefits of CARB's longstanding heavy-duty mobile source program, emissions in the South Coast from this source category have been reduced significantly since 1990, and will continue to decrease through 2030. From today, medium- and heavy-duty NOx emissions are projected to decrease by over 76 percent in 2030, emissions of direct PM are projected to decrease by approximately 28 percent in the same timeframe.

Figure 4: Heavy-Duty Control Measures



The major regulatory and programmatic control measures that provide emission reductions in the on-road heavy-duty mobile source category are described below.

NEW VEHICLE AND ENGINE STANDARDS

Heavy-duty engine emission standards (mandatory standards)

California is the only state with the authority to adopt and enforce emission standards for new motor vehicle engines that differ from the federal emission standards. A central element of CARB's heavy-duty diesel vehicle program is requiring that new trucks, buses and on-road diesel engines meet increasingly stringent engine emission standards. CARB has phased-in implementation of these increasingly stringent ***new heavy-duty vehicle and engine emission standards*** since the mid 1980's, resulting in significant emission reductions.

As shown in Table 11, California PM and NOx engine emission standards have historically been more stringent than applicable federal standards on several occasions, as indicated in the darker shaded portions of the table. In these instances, California has, functioning as a 'laboratory' state, paved the way for later federal increases in the stringency of PM and NOx emission standards. These standards reflect the increased efficiency in control technologies over time, as innovations in vehicles, engines, and emission-capturing technology progress. Since 1990**,** heavy-duty engine NOx emission standards have become dramatically more stringent, dropping from 6 grams per brake horsepower-hour (g/bhp-hr) in 1990 down to a 0.2 g/bhp-hr NOx standard, which took effect in 2010. Due to these requirements, new heavy-duty trucks sold since 2010 emit 98 percent less NOx and PM2.5 than new trucks sold in 1986.

On August 26, 2005, CARB obtained a waiver from the federal preemption for the Engine Standards for 2007 and Subsequent Model Year Heavy-Duty Diesel Engines/Vehicles regulation, which generally aligned California's mandatory heavy-duty emission exhaust standards with the federal standards for 2007 and subsequent model year vehicles and engines. Subsequent mandatory exhaust emission standards for heavy-duty engines that CARB has developed and adopted have aligned with federal standards until the 2021 ***Heavy-Duty Omnibus Regulation***, a measure in the 2016 State SIP Strategy, which further reduced California's NOx and PM limits for MY 2024 and subsequent years. When fully implemented in 2027, the Omnibus regulation will set NOx emission limits at 0.020 (miles ≤ 435,000), and 0.035 (435,000 - 600,000 miles), and PM emission limits at 0.005 g/bhp-hr.

Table 11: Adopted California and Federal Heavy-Duty Engine Emission Standards

(for compression-ignition engines, shown in g/bhp-hr)

Model Year	California NOx		Federal NOx	California PM		Federal PM	
	General	Urban Buses		General	Urban Buses	General	Urban Buses
1985 -86	10.7		10.7	n/a		n/a	
1987	6.0		10.7	0.60		n/a	
1988 - 89	6.0		10.7	0.60		0.60	
1990	6.0		6.0	0.60		0.60	
1991 - 92	5.0		5.0	0.25	0.10	0.25	
1993	5.0		5.0	0.25	0.10	0.25	0.10
1994 - 95	5.0	5.0 3.50 - 0.50 Optional (1995+)	5.0	0.10	0.07	0.10	0.07
1996 - 97	5.0	4.0 2.50 - 0.50 Optional	5.0	0.10	0.05* *(*0.07 in-use)*	0.10	0.05* *(*0.07 in-use)*
1998 - 03	4.0 2.50 - 0.50 Optional		4.0	0.10 0.03 – 0.01 Optional (2002+)	0.05* *(*0.07 in-use)*	0.10	0.05* *(*0.07 in-use)*
2004 - 06	2.0	0.50 - 0.01	2.0	0.10 0.03 – 0.01 Optional	0.01	0.10	0.05* *(*0.07 in-use)*
2007 - 09	0.20* *phased-in (*fleet avg ~1.2)*	0.20	0.20* *phased-in (*fleet avg ~1.2)*	0.01		0.01	
2010 - 14	0.20		0.20	0.01		0.01	
2015 - 23	0.20 0.10 – 0.02 Optional		0.20	0.01		0.01	
2024 - 26	0.050 (0.020 Optional)		0.20	0.005		0.01	
2027 - 30	0.020 (miles ≤ 435,000), and 0.035 (435,000 - 600,000 miles) (0.010 Optional)		0.035	0.005		0.005	
2031+	0.020 (miles ≤ 435,000), and 0.040 (435,000 - 800,000 miles) (0.010 Optional)		0.035	0.005		0.005	

The Omnibus Regulation implemented two key measures in the 2016 State SIP Strategy: the Low-NOx Engine Standard, and the Lower In-Use Emission Performance Level measures. The Omnibus Regulation established stringent NOx and PM engine emission standards that, when fully implemented, will be 90 percent below current levels on existing certification cycles, and lower NOx standards on new certification cycles to control emissions over a broader range of vehicle operation, including idling, low load, and highway operation. In addition, the Omnibus Regulation revised the

heavy-duty in-use testing program to make it more effective in ensuring compliance with the in-use emission standards over a broader range of vehicle operation and lengthened the useful life and emissions warranty period requirements to reflect the longevity of heavy-duty vehicles.

To support the Omnibus rulemaking, CARB, in partnership with federal and local air agencies and the heavy-duty engine industry, have funded over $5 million worth of research contracts with South Research Institute (SwRI) to evaluate various engine and emission control strategies to reduce NOx emissions from heavy-duty engines by 90 percent without or with minimal GHG impacts. The results from these contracts referred to as the Stage 1,[61] Stage 2,[62] and Stage 3[63] Heavy-Duty Low NOx Programs formed the bases for supporting the Omnibus Regulation. In addition, CARB had also contracted with the National Renewable Energy Laboratory to conduct a cost analysis for compliance with CARB's proposed lower NOx exhaust emission standards on current certification test cycles and a new low-load certification test cycle, as well as cost associated with increasing the useful life and emission warranty period requirements.[64]

Optional heavy-duty engine emission standards

In addition to mandatory NOx standards, CARB has also adopted several generations of ***optional lower NOx standards*** over the past 15 years. The optional standards allow local air districts and CARB to preferentially provide incentive funding to buyers of cleaner trucks, which encourages the development of cleaner engines, which in turn paves the way for future lower-NOx emission standards.

- From 1998 to 2003, optional NOx standards ranged from 0.5 g/bhp-hr to 2.5 g/bhp-hr, at 0.5 g/bhp-hr increments, which was much lower than the mandatory 4 g/bhp-hr limit.
- Starting in 2004, engine manufacturers could choose to certify to optional NOx + non--methane hydrocarbon (NMHC) standards ranging from 0.3 g/bhp-hr to 1.8 g/bhp-hr, at 0.3 g/bhp-hr increments, which was significantly below the mandatory 2.4 g/bhp-hr NOx+NMHC standard.
- In ongoing efforts to go beyond federal standards and achieve further reductions, CARB adopted in 2013 the ***Optional Reduced Emissions Standards for Heavy-Duty Engines*** regulation, which established the new generation of optional NOx emission standards for heavy-duty engines, and a certification pathway for a new generation of requirements for heavy-duty engines. Starting in 2015, engine manufacturers could certify to three optional NOx emission standards of 0.1 g/bhp-hr, 0.05 g/bhp-hr, and 0.02 g/bhp-hr (i.e., 50 percent,

[61] SwRI, 2017. "Evaluating Technologies and Methods to Lower NOx Emissions from Heavy-Duty Vehicles, Final Report" https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/past/13-312.pdf
[62] SwRI, 2020. "Heavy-Duty Engine Low-Load Emission Control Calibration, Low-Load Test Cycle Development, and Evaluation of Engine Broadcast Torque, and Fueling Accuracy During Low-Load Operations, Final Report" https://www.arb.ca.gov/lists/com-attach/1-hdomnibus2020-VDdXMFIhU2IAWQIw.pdf
[63] SwRI, 2021. "Further development and Validation of Technologies to Lower NOx Emissions from Heavy-Duty Vehicles, Final Report" https://www.arb.ca.gov/lists/com-attach/79-hdomnibus2020-Uj4AaQB2Aj8FbAhw.pdf
[64] NREL, 2020. "On-Road Heavy-Duty Low-NOx Technology Cost Study" https://www.nrel.gov/docs/fy20osti/76571.pdf

75 percent, and 90 percent lower than then-current mandatory standard of 0.2 g/bhp-hr). This optional standard has resulted in substantial investments in California's heavy-duty fleets over the past decade in order to adopt modern, lower-emitting vehicles and equipment.

- Most recently, in ***2021, the Heavy-Duty Omnibus Regulation*** lowered CARB's optional NOx emission standards to 0.020 g/bhp-hr for MY 2024-26 and to 0.010 g/bhp-hr for MY 2027+.

Zero-Emission Truck Standards

Although ZEV technologies are not as mature for heavy-duty trucks as they are in the passenger vehicle sector, Class 3 - 7 delivery trucks and urban buses provide opportunities for the deployment of zero-emission technologies in targeted applications, due to their duty cycle, are well-suited to the initial introduction of heavy-duty zero-emission engines. Transit buses, last mile delivery vehicles, and airport shuttle buses are typically operated on short-distance fixed routes and are centrally housed and may be captive to a District – characteristics that make these applications ideally suited to deploying zero-emission vehicles in targeted heavier applications, preceding broader penetration in the heavy-duty engine market. These initial deployments provide a foundation for subsequent migration of zero-emission technology to other heavier platforms, in order to continue to expand heavy-duty ZEV requirements in the long term, especially in certain vocational classes and fleets that are under California regulatory authority.

In June 2020, CARB adopted the ***Advanced Clean Trucks Regulation (ACT),*** a measure in the 2016 State SIP Strategy, which is a first of its kind regulation requiring medium- and heavy-duty manufacturers to produce ZEVs as an increasing portion of their sales beginning in 2024. This regulation is expected to result in roughly 100,000 ZEVs by 2030, and nearly 300,000 ZEVs by 2035. The Advanced Clean Trucks Regulation is part of a holistic approach to accelerate a large-scale transition of zero-emission medium-and heavy-duty vehicles from Class 2b to Class 8. The regulation has a manufacturer sales requirement that requires manufacturers who certify Class 2b-8 chassis or complete vehicles with combustion engines to sell zero-emission trucks as an increasing percentage of their annual California sales from 2024 to 2035. By 2035, zero-emission truck/chassis sales would need to be 55 percent of Class 2b – 3 truck sales, 75 percent of Class 4 – 8 straight truck sales, and 40 percent of truck tractor sales. U.S. EPA recently issued a waiver of preemption for the Advanced Clean Trucks Regulation in March 2023.

In analyzing the feasibility of this regulation, CARB staff analyzed what types of trucks are currently suitable for electrification, the amount and variety of commercially available zero-emission trucks, as well as the cost of charging and ownership of battery electric trucks. Currently, medium- and heavy-duty electric drivetrains are well suited to operating in congested urban areas for stop-and-go driving where conventional engines are least efficient. Battery-electric and fuel-cell electric trucks, buses, and vans already are being used by fleets that operate locally and have predictable daily use where the trucks return to base to be charged or fueled. There are more than 70 different models

of zero-emission vans, trucks and buses that already are commercially available from several manufacturers. Most trucks and vans operate less than 100 miles per day and several zero-emission configurations are available to serve that need. As technology advances, zero-emission trucks will become suitable for more applications. Most major truck manufacturers have announced plans to introduce market ready zero-emission trucks in the near future. The electricity cost to charge battery electric trucks varies based on how fast you charge, the utility rate, and the time of day. In many cases, a fleet owner who also owns charging stations and charges trucks overnight can have little to no net electricity costs after the Low Carbon Fuel Standard (LCFS) credits in California are included. Zero-emission trucks have higher upfront costs but have lower operating costs than conventional trucks. Currently, the total cost of ownership in California can be comparable to conventional trucks for certain duty cycles without grants or rebates. As battery prices fall and technology continues to improve, the total cost of ownership is expected to become more favorable. Incentives are currently available to offset some or all of the higher vehicle capital costs and some of the early infrastructure costs to help fleets begin transitioning to zero-emission vehicles now.

To date, six other states have adopted the California requirements of the Advanced Clean Trucks regulation under the provisions of Section 177 of the Act: Massachusetts, Vermont, New Work, New Jersey, Washington, and Oregon. 17 states, the District of Columbia, and the Province of Quebec, Canada, also have medium- and heavy-duty ZEV commitments.

Warranty Requirements and Useful Life

In 1978, CARB adopted ***Emission Warranty Regulations*** to clarify the rights and responsibilities of individual motor vehicle and engine owners, motor vehicle and engine manufacturers, and the service industry. The emission warranty is used to cover any repairs needed to correct defects in materials or workmanship which would cause an engine or vehicle not to meet its applicable emission standards. In 1982, CARB adopted regulations that established California's first in-use recall program. These regulations were intended to reduce vehicular emissions by ensuring that noncompliant vehicles are identified, recalled, and repaired to comply with the applicable emission standards and regulations during customer use, and to encourage manufacturers to improve the design and durability of emission control components to avoid the expense of a recall. Throughout the 1980's CARB adopted several regulations, such as the Emission Warranty Information Reporting program, which work in conjunction with the warranty regulations to identify malfunctioning emission control components and encourage repair. In 1982 and 1984, U.S. EPA promulgated heavy-duty vehicle useful life and warranty requirements identical to those adopted in California. Both U.S. EPA and CARB require that heavy-duty vehicles meet emission standards throughout their useful life periods. The current heavy-duty vehicle emission warranty period is 100,000 miles for all categories of heavy-duty vehicles with GVWR greater than 14,000 lbs.

Since the 2007 model year, all on-road heavy-duty diesel vehicles and heavy-duty diesel engines have been subject to stringent PM and NOx emission standards. Manufacturers have met these standards by equipping new heavy-duty diesel engines

with diesel particulate filters (DPF) for control of PM, and beginning with the 2010 model year have also included systems for controlling NOx using exhaust gas recirculation (EGR) and selective catalytic reduction systems. These emission control systems can reduce NOx emissions by more than 95 percent and PM emissions by more than 99 percent. Therefore, if these components fail, an individual engine's and vehicle's emissions can dramatically increase. It is therefore crucial that these emission control systems continue to function as designed throughout a vehicle's life to ensure emissions remain low.

To update the on-road heavy-duty diesel vehicles warranty period, which had not changed substantially in California for almost 40 years (trucks were required to be covered by only a 5 year, 100,000 mile, or 3,000 hour emissions warranty period, whichever first occurred), CARB amended the warranty regulation for on-road heavy-duty vehicles with GVWR greater than 14,000 pounds in 2018 with the ***Amendments to California Emission Control System Warranty Regulations and Maintenance Provisions Regulation.*** For model year 2022 and later engines, these amendments lengthened existing warranty periods and maintenance provisions to better reflect the longevity and usage of modern vehicles, and to help ensure adequate durability and proper maintenance of the engine and emission controls. For MY 2022 - 2026, the useful life requirements for are the same for CARB and federal regulations. U.S. EPA warranty provisions cover 100,000 miles, or 5 years / 3,000 hours, for Class 4 – 8 trucks; California's more stringent warranty provisions cover:

- Class 8: 350,000 miles, or 5 years
- Class 6 – 7: 150,000 miles, or 5 years
- Class 4 – 5: 110,000 miles, or 5 years

The amendments also updated the minimum maintenance intervals so that vehicle owners do not inadvertently negate the proposed lengthened warranty periods, and explicitly link the heavy-duty On-Board Diagnostic (HD OBD) system to the definition of warranted parts, to help take full advantage of all of the tools available for ensuring the control of in-use emissions and to be consistent with the long-established link existing for light- and medium-duty vehicles.

Emissions warranties are intended to provide a level of assurance to the vehicle owner that the engine and its associated emission control systems are unlikely to experience defects in materials and workmanship that could result in the engine not performing as required. If such defects do occur during the warranty period, the manufacturer is liable for fixing them. Lengthened warranty periods may also reduce incidences of tampering and mal-maintenance. For example, there would be little incentive for a vehicle owner to tamper with the vehicle's emission control system, such as by coring out a DPF or bypassing a catalyst, when the manufacturer is obligated to pay for any defect-related repairs. Furthermore, vehicle owners would also have more of an incentive to timely perform scheduled maintenance so as not to void their lengthened warranty. Additionally, lengthened warranty periods are needed to protect heavy-duty vehicle owners from potentially high repair costs under the requirements of CARB's recent amendments to the Periodic Smoke Inspection Program (PSIP) and Heavy-Duty

Vehicle Inspection Program (HDVIP), which include much stricter opacity limits intended to spur more vehicle owners to make timely engine repairs and replace DPFs.

CARB analyses of feasibility found evidence supporting the need for longer minimum warranties within manufacturers' warranty claim data for heavy-duty vehicles, as well as from recent CARB testing of in-use heavy-duty vehicles. Specifically, CARB's test programs had identified numerous heavy-duty vehicles with mileages within their applicable regulatory useful life periods, but beyond their warranty period, that had NOx emission levels significantly above their applicable certification standards.

In 2020, the ***Heavy-Duty Omnibus Regulation*** further amended the warranty and useful life provisions for heavy-duty engines. To help ensure emission controls are well-maintained and repaired when needed, and to help ensure more durable emission control systems, the Omnibus Regulation extends the criteria pollutant emissions warranty and useful life period requirements for heavy-duty vehicles and engines, as shown in Table 12 and Table 13. The revisions would be phased-in beginning with the 2027 model year engines with the final phase-in occurring in 2031.

Table 12: Useful Life Periods

Model Year	Useful Life (miles)			
	Class 4 – 5 Diesel	Class 6 – 7 Diesel	Class 8 Diesel	Heavy-Duty Otto
Current – 2026	110,000 miles 10 years	185,000 miles 10 years	435,000 miles 10 years 22,000 hours	110,000 miles 10 years
2027–2030	190,000 miles 12 years	270,000 miles 11 years	600,000 miles 11 years 30,000 hours	155,000 miles 12 years
2031 and subsequent model years	270,000 miles 15 years	350,000 miles 12 years	800,000 miles 12 years 40,000 hours	200,000 miles 15 years

Table 13: Warranty Periods

Model Year	Warranty (miles)			
	Class 4 – 5 Diesel	Class 6 – 7 Diesel	Class 8 Diesel	Heavy-Duty Otto
Current – 2026	110,000 miles 5 years	150,000 miles 5 years	350,000 miles 5 years	50,000 miles 5 years
2027–2030	150,000 miles 7 years / 7,000 hours	220,000 miles 7 years / 11,000 hours	450,000 miles 7 years 22,000 hours	110,000 miles 7 years / 6,000 hours
2031 and subsequent model years	210,000 miles 10 years / 10,000 hours	280,000 miles 10 years / 14,000 hours	600,000 miles 10 years 30,000 hours	160,000 miles 10 years / 8,000 hours

OBD Requirements

In addition to new vehicle emission standards for the heavy-duty fleet, CARB's suite of control measures also includes actions to ensure that the in-use fleet continues to operate as cleanly as possible through requiring that new vehicles come equipped with in-use inspections and on-board self-diagnostic equipment. OBD systems are designed to identify when a vehicle's emission control systems or other emission-related computer-controlled components are malfunctioning, causing emissions to be elevated above the vehicle manufacturer's specifications.

The first generation of OBD systems (referred to as OBD I) applied to medium-duty vehicles. OBD I was implemented by CARB in 1988 and required monitoring of only a few of the emission-related components on the vehicle. In 1989, CARB adopted regulations requiring a second generation of OBD systems (OBD II) that standardized the system and addressed the shortcomings of the OBD I requirements and required that all 1996 and newer medium-duty vehicles and engines to be equipped with OBD II systems.

In 2004, CARB adopted the first regulation requiring OBD systems on heavy-duty vehicles, knowns as the Engine Manufacturer Diagnostic (EMD) regulation. The EMD Regulation required manufacturers of heavy-duty engines and vehicles to implement diagnostic systems on all 2007 and subsequent MY on-road heavy-duty engines. The EMD Regulations were much less comprehensive than the OBD II regulations and were intended for heavy-duty manufacturers to achieve a minimum level of diagnostic capability. In 2005, CARB adopted ***Heavy-Duty Specific OBD Requirements (HD OBD)***, which applied to 2010 and subsequent model year heavy-duty engines and vehicles (i.e., vehicles with a gross vehicle weight rating greater than 14,000 pounds). This regulation required by 2013 that all heavy-duty engines offered for sale in California come equipped with OBD systems. U.S. EPA issued a waiver of preemption for the California 2010 Model Year Heavy-Duty Vehicle and Engine On-Board

Diagnostic Standards in 2008, and has also issued two subsequent waivers for amendments CARB has made to the heavy-duty OBD requirements in later years to increase the stringency of these requirements.[65]

The emission "thresholds" for faults that must be detected by OBD systems are typically either a multiple of the exhaust emission standard (e.g., 2.0 times the applicable standard), or an additive value above the standards (e.g., 0.2 g/bhp-hr above the applicable standards). For the most important emission control systems such as the PM filter and SCR system, the OBD regulation specifies malfunction criteria and emission thresholds for detecting a malfunction and illuminating the MIL based on emission increases (defined by additive and multiplicative factors) relative to the emission standard. For example, on 2016 and subsequent MY diesel engines, the OBD system must be designed to detect an SCR catalyst malfunction when the catalyst has deteriorated to the point that the engine's emissions are exceeding the NOx standard by more than 0.2 g/bhp-hr (e.g., cause NOx emissions to exceed 0.4 g/bhp-hr if the exhaust emission standard is 0.20 g/bhp-hr).

Under ***the Heavy-Duty Omnibus Regulation***, NOx emission standards will, upon full implementation with MY 2027 and later years, be reduced to a tenth of the current 0.20 g/bhp-hr standard, and PM standards to one half of today's standard. Because the OBD emission thresholds are often defined as an additive or multiplicative function of the standard, without amendments to the OBD threshold requirements, the OBD thresholds would similarly be reduced along with the proposed standards (e.g., the NOx threshold would become 2.0 times the new lower emission standard). While detection of faults at these proportionally lower levels will likely be required in the future as it will be necessary to ensure the maximum benefits of the proposed standards are maintained in-use, the engine manufacturers have expressed concern about not knowing with certainty what impact the lower standards will have on their OBD monitoring capability. As such, the engine manufacturers have requested interim relief until they have more certainty on what emission thresholds are achievable. To address engine manufacturers' concerns regarding not knowing with certainty at what emission levels their OBD systems will be able to detect faults, CARB staff is amending both the HD OBD Regulation and the OBD II Regulation (for engines used in medium-duty vehicles) with the Omnibus Regulation, which will provide an interim level of relief for manufacturers by maintaining OBD thresholds for NOx and PM effectively at the same levels as required for today's standards. With this relief, engine manufacturers can first focus on the necessary emission control solutions to meet the current standards before turning to improvements that may be necessary to ensure robust detection of faults at the lower emission levels. Omnibus also requires updates to address cold start emissions and diesel PM monitoring.

REDUCING IN-USE EMISSIONS

While increasingly stringent standards for new vehicles and engines collectively ensure that new vehicles are as clean as possible, older, higher-emitting heavy-duty vehicles

[65] U.S. EPA 2012 "California State Motor Vehicle Pollution Control Standards; Amendments to the California Heavy-Duty Engine On-Board Diagnostic Regulation; Waiver of Preemption; Final Notice of Decision" Federal Register Volume 77, Number 237 pp. 73459-73461 https://www.gpo.gov/fdsys/pkg/FR-2012-12-10/pdf/2012-29792.pdf

with long useful lifecycles can remain on the road for many years. To address this legacy fleet, CARB has adopted heavy-duty vehicle in-use control measures to significantly reduce PM2.5 and NOx emissions from existing diesel vehicles operating in California. These measures fall within three categories: measures that utilize inspections and maintenance programs in order to improve in-use emission performance levels; truck idling requirements; and fleet turnover rules.

Inspection and Maintenance (I/M) Program

CARB also adopted a suite of control measures to lower in-use emission performance levels to ensure that the heavy-duty vehicles in the in-use fleet continue to operate at their cleanest possible level.

Opacity Limits

The ***Heavy-Duty Vehicle Inspection Program (HDVIP)***, adopted into law in 1988, requires heavy-duty vehicles to be inspected for smoke opacity (i.e., excessive smoke), tampering, and engine certification label compliance. Any heavy-duty vehicle operating in California, including vehicles registered in other states and foreign countries, may be inspected. Inspections are performed by CARB inspection teams at border crossings, California Highway Patrol weigh stations, fleet facilities, and randomly selected roadside locations.

To ensure that in-use heavy-duty vehicles continue to operate at their cleanest possible level CARB's 2018 amendments to the ***Periodic Smoke Inspection Program (PSIP)*** and HDVIP programs lowered the opacity limits for on-road heavy-duty trucks beyond the existing opacity limits (40 and 55 percent), which were no longer adequate to identify and require repairs of vehicles operating with damaged PM emission control components – even vehicles with heavily damaged and malfunctioning emission control systems emit exhaust at opacity levels below those opacity limits. To tighten these standards, and further control emissions form the many HD vehicles operating in California emitting excess PM emissions, staff developed lower opacity limits which reflect the current emission control technology equipped on today's HD diesel vehicles. ***The 2018 Amendments to the Periodic Smoke Inspection Program (PSIP)*** require all California-based fleets of two or more heavy-duty diesel vehicles over 6,000 pounds GVWR with engines over four years old are required to perform annual smoke opacity tests (1998 and newer diesel vehicles between 6,000–14,000 pounds GVWR subject to biennial smog check are not subject to PSIP). Allowable levels of Smoke Opacity are shown in Table 14 below.

Table 14: Allowable Levels of Smoke Opacity

Engines Equipped with a DPF	
5% Opacity Limit	
Pre-2007 Model Year (MY) Engines without a DPF	
1997– 2006 MY Engines	20% Opacity Limit
1991–1996 MY Engines	30% Opacity Limit
Pre-1991 MY Engines	40% Opacity Limit
Engines Equipped with a Level 2 Verified Diesel Emission Control Strategy (VDECS)	
20% Opacity Limit	
Two-Engine Cranes Driven by a non-DPF Off-Road Engine	
40% Opacity Limit	

The amendments also help to improve the identification and repair of malfunctioning PM emission control components on HD diesel vehicles in California. Lowering the opacity limits to the newer levels helps to ensure that the opacity limits are more representative of current PM emission control technology, and that vehicles operating with malfunctioning PM emission control components are more readily identified and repaired.

I/M Testing

All heavy-duty vehicles in California are subject to in-use inspections in order to control excessive smoke emissions and tampering. The ***Periodic Smoke Inspection Program (PSIP)***, adopted in 1990, requires heavy-duty vehicle fleet owners to conduct annual smoke opacity inspections of their vehicles, and have them repaired if excessive smoke emissions are observed. In addition, CARB has the authority to randomly audit these fleets, by reviewing the owners' maintenance and inspection records, and conducting opacity inspections on a representative sample of the vehicles. The current PSIP opacity limits are the same as for HDVIP (40 and 55 percent).

To ensure that in-use heavy-duty vehicles continue to operate at their cleanest possible level, the ***2020 Heavy-Duty Omnibus Regulation*** amended the Heavy-Duty In-Use Testing (HDIUT) Program by revising procedures to better represent heavy-duty vehicle operations in real world conditions, establishing clearer criteria for engine family pass/fail determination, and requiring OBD data during testing to verify the condition of the test vehicle and sensors. These amendments apply to 2024 and subsequent model year engines, and replace the current NTE-based methodology with a new three-bin moving average windows-based methodology. The three bins cover idle, low load, and medium to high load operation. Compliance would be determined by comparing the average NOx emissions for each bin to the in-use threshold, defined as one and a half times the applicable standard for the model year.

The Omnibus Regulation also established a new standardized methodology for demonstrating durability. The standardized methodology increases the default break-in period from the current 125 hours to 300 hours for on-road heavy-duty diesel engines, and requires standardized certification cycles for engine and aftertreatment system

aging in order to validate component durability and determine exhaust emissions deterioration factors. It also requires additional engine aging (i.e., increased durability hours) compared to what existing certification requirements, allowing manufacturers to use accelerated aging cycles for a portion of the useful life demonstration for aftertreatment systems, provided that those manufacturers periodically submit in-use emissions data generated from their on-road heavy-duty diesel engines.

Additionally, heavy-duty vehicles registered in California are now required to demonstrate annual compliance with HD I/M program requirements in order to register with the Department of Motor Vehicles, under ***the Heavy-Duty Inspection and Maintenance Program (HD I/M).*** Senate Bill 210 (Leyva, Chapter 298, Statutes of 2019) directed CARB to develop and implement a comprehensive heavy-duty vehicle inspection and maintenance regulation requiring periodic vehicle emissions testing and reporting on nearly all heavy-duty vehicles operating in California. The Board approved the HD I/M regulation on December 9, 2021, with implementation to be phased in starting January 2023. Combining periodic vehicle testing with other emissions monitoring and expanded enforcement strategies, the HD I/M regulation ensures that vehicles' emissions control systems are properly functioning when traveling on California's roadways, and that polluting, poorly maintained heavy-duty vehicles operating in California are quickly identified and repaired. At full implementation, the HD I/M regulation will require heavy-duty vehicles to undergo periodic emissions testing to reduce PM and NOx emissions, and to protect communities most impacted by air pollution.

Beginning in January 2023, CARB is using roadside emissions monitoring devices (REMD) to screen for vehicles that may have high emissions. Vehicles flagged as potential high emitters may be required to undergo follow-up vehicle compliance testing to ensure they are operating with properly functioning emissions control systems. If a vehicle is identified as a potential high emitter through REMD, the owner will receive a Notice to Submit to Testing (NST) from CARB. Upon receival, they will have 30 calendar days to submit to CARB a passing HD I/M compliance test performed by a HD I/M tester. The type of HD I/M compliance test a vehicle will undergo depends on whether it is equipped with OBD or not. OBD-equipped vehicles are required to undergo a scan of the engine's OBD data using a CARB-validated OBD test device. Diesel vehicles and diesel hybrids with 2013 and newer model year engines have OBD systems. For alternative fuel vehicles, 2018 and newer model year engines have OBD systems. Non-OBD vehicles, i.e., those that don't meet the engine model year requirements, are required to undergo a smoke opacity test and a visual inspection of the vehicle's emissions control equipment, referred to as the Vehicle Emissions Control Equipment Inspection. Vehicles that are currently subject to PSIP must still perform their annual compliance inspections.

Starting in mid-2023, vehicle owners will be required to create owner accounts in CARB's HD I/M database, verify the vehicles in their fleets, and pay the first annual compliance fee for each vehicle. Once enforcement begins, vehicle owners that don't comply with these requirements may be cited for non-compliance and/or have their DMV vehicle registrations blocked. Upon enforcement of the requirements to establish owner accounts with vehicle information as described above, freight contractors and

brokers must verify that heavy-duty vehicles they contract with for services are in compliance with the HD I/M regulation. This also includes public agencies that contract for heavy-duty truck services. Furthermore, seaport and railyard facilities must also verify compliance with the HD I/M regulation for vehicles that enter their facilities.

HD I/M periodic compliance testing for all vehicles that operate in California will start no earlier than January 1, 2024. Upon implementation of HD I/M periodic compliance testing, nearly all vehicles will be required to undergo twice per year testing with results submitted to CARB. On-road agricultural vehicles and California-registered motorhomes only will be required to undergo testing once per year. Three years after the start of HD I/M periodic compliance testing, OBD equipped vehicles will be required to undergo testing four times per year. On-road agricultural vehicles and California-registered motorhomes will remain on the once per year testing frequency, even if equipped with OBD.

Idling Requirements

To reduce idling emissions from new heavy-duty diesel vehicles and emissions from auxiliary power units used as alternatives to heavy-duty vehicle idling, the Airborne Toxic Control Measure (ATCM) to Limit Diesel-Fueled Commercial Motor Vehicle Idling ***(Heavy-Duty Diesel Vehicle Idling Reduction Program)*** requires, among other things, that drivers of diesel-fueled commercial motor vehicles with gross vehicle weight ratings greater than 10,000 pounds, including buses and sleeper berth equipped trucks, not idle the vehicle's primary diesel engine longer than five minutes at any location. First adopted in July 2004 and subsequently amended, the regulation consists of new engine and in-use truck requirements and emission performance requirements for technologies used as alternatives to idling the truck's main engine. Under the new engine requirements, 2008 and newer model year heavy-duty diesel engines need to be equipped with a non-programmable engine shutdown system that automatically shuts down the engine after five minutes of idling. In 2012, U.S. EPA issued a waiver of preemption for the most recent amendments made to the Idling Reduction Program in 2006, beginning in model year 2008.[66] The ***Heavy-Duty Omnibus Regulation*** reduces idling limits for heavy-duty diesel vehicles from 30 g/hr to 10 g/hr in MY 2024, and to 5 g/hr in MY 2027.

Fleet Rules

CARB's ***Cleaner In-Use Heavy-duty Truck Regulation (Truck and Bus Regulation)*** impacts approximately one million inter- and intra-state vehicles and requires privately and federally owned diesel fueled trucks and buses and privately and publicly owned school buses to fully upgrade to newer, cleaner engines by 2023. This regulation leverages the benefits provided by new truck emission standards by accelerating introduction of the cleanest trucks. The Truck and Bus Regulation was adopted in December 2008, and was amended in both December 2010 and December 2014. The regulation represents a multi-year effort to turn over the legacy fleet of engines and replace them with the cleanest technology available. While heavy-duty engine

[66] U.S. EPA 2012 "California State Motor Vehicle and Nonroad Engine Pollution Control Standards; Truck Idling Requirements; Final Notice of Decision" Federal Register Volume 77, Number 32, pp. 9239-9250 http://www.gpo.gov/fdsys/pkg/FR-2012-02-16/pdf/2012-3690.pdf

technology has become significantly cleaner in the past few decades, the long useful lives of some heavy-duty engines means that older, higher-emitting trucks remain on the road for many years after newer generations of engine standards have gone into effect.

Starting in 2012, the Truck and Bus Regulation phased in requirements so that by 2014, nearly all vehicles operating in California will have PM emission controls, and by 2023 nearly all vehicles meet 2010 model year engine emissions levels. The regulation applies to nearly all diesel fueled trucks and buses with a GVWR greater than 14,000 pounds that are privately or federally owned, including on-road and off-road agricultural yard goats, cargo handling equipment, drayage trucks, solid waste collection vehicles, and school buses. Moreover, the regulation applies to any person, business, school district, or federal government agency that owns, operates, leases or rents affected vehicles. The regulation also establishes requirements for any in-State or out-of-State motor carrier, California-based broker, or any California resident who directs or dispatches vehicles subject to the regulation. Finally, California sellers of a vehicle subject to the regulation must disclose the regulation's potential applicability to buyers of the vehicles. In January 2017, U.S. EPA granted a waiver of preemption for the portions of the Truck and Bus Regulation for which a waiver was required.[67]

To move beyond combustion engines toward electrification of the heavy-duty fleet, CARB recently approved the ***Advanced Clean Fleets Regulation***, which will accelerate the market for zero-emission trucks, vans, and buses by requiring fleets that are well suited for electrification, to transition to ZEVs where feasible. With the adoption of the Advanced Clean Trucks Regulation, CARB Resolution 20-19 directed staff to return to the Board with a zero-emission fleet rule and sets the following targets for transitioning sectors to ZEVs:

- 100 percent zero-emission drayage, last mile delivery, and government fleets by 2035;
- 100 percent zero-emission refuse trucks and local buses by 2040;
- 100 percent zero-emission-capable vehicles in utility fleets by 2040; and
- 100 percent zero-emission everywhere else, where feasible, by 2045.

Achieving these and other milestones also contributes to meeting the goals in the Governor's Executive Order N-79-20. With the Advanced Clean Fleets Regulation, CARB anticipates developing a regulatory action that will accelerate ZEV adoption in the medium- and heavy-duty sectors by setting zero-emission requirements for fleets. The ***Advanced Clean Fleets Regulation*** accelerates ZEV adoption in the medium-to heavy-duty sectors and for light-duty package delivery trucks by setting zero-emission requirements for fleets. This regulation targets drayage trucks, public fleets, and other high priority fleets with 50 or more trucks or entities with trucks and $50 million in annual revenues. This effort is part of a comprehensive strategy to achieve a ZEV truck and bus fleet by 2045 everywhere feasible, and significantly earlier for certain well-suited

[67] U.S. EPA 2017 "Final Notice of Decision - On-Highway Heavy-Duty Vehicle and Engine Regulations for 2007 and Subsequent Model Years" Accessed April 30, 2017 at https://www.gpo.gov/fdsys/pkg/FR-2017-01-17/pdf/2017-00940.pdf Federal Register / Vol. 82, No. 10 / Tuesday, January 17, 2017 pp. 4867

market segments such as last mile delivery, drayage, and government fleets. The regulation will phase in ZEV requirements for different fleets, including components as follows:

- Beginning January 1, 2024, all additions to High Priority fleets (fleets with 50 or more trucks or entities with trucks and $50 million in annual revenues) and federal fleets must be ZEVs, and all combustion vehicles must be removed from the California fleet at the end of their useful life, or fleets may opt to phase-in ZEV requirement where a portion of the fleet must be zero-emission based on a pre-determined schedule.
- State and local government fleets including cities, counties, special districts, and other municipalities would be required to add only ZEVs to their fleets starting at 50 percent of new additions in 2024 and 100 percent starting in 2027 or fleets may opt to phase-in ZEV requirement where a portion of the fleet must be zero-emission based on a pre-determined schedule. Small public fleets or those that are based in designated low population counties would begin with 100 percent ZEV additions starting in 2027.
- Beginning January 1, 2024, any truck added to drayage service would need to be a ZEV. All drayage trucks entering seaports and intermodal railyards would be required to be zero-emission by 2035.
- 100 percent of medium- and heavy-duty vehicle sales in California would be zero-emissions starting in 2036.

Due to the recently-approved Advanced Clean Fleets Regulation and the Advanced Clean Truck Regulation, the number of medium- and heavy-duty ZEVs operating in California will be about 1.7 million by 2045.

In analyzing the feasibility of this regulation, CARB staff found that medium- and heavy-duty ZEVs that are commercially available today are already capable of meeting the daily needs of most local and regional trucking operations, and a variety of vocational uses. Fleet owners reported information about their vehicles and operations as part of the Large Entity Reporting program;[68] data collected in 2021 that shows that the vast majority of trucks drive 100 miles or fewer per day. Today's medium- and heavy-duty ZEVs have energy storage systems that can meet most of these daily operational requirements. As technology advances, zero-emission trucks will become suitable for more applications. Most major truck manufacturers have announced plans to introduce market ready zero-emission trucks in the near future.

Zero-emission truck availability (as of July 2022):

- 148 models in North America are available for order or pre-order. There are more than 70 different models of zero-emission vans, trucks and buses that already are commercially available from several manufacturers.
- 135 models are actively being produced and delivered to customers.

[68] Large Entity Reporting https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks/large-entity-reporting

- At least 35 manufacturers are producing vehicle Class 2b through 8 ZEVs.

Another measure committed to in the 2022 State SIP Strategy, the ***Zero-Emission Trucks Measure,*** is also being developed, designed to accelerate the number of zero-emissions trucks beyond existing measures (including the Advanced Clean Fleets Regulation and Advanced Clean Truck Regulation): the previously adopted Advanced Clean Truck Regulation will result in almost 420,000 ZE trucks on the road by 2037, and the more recently adopted Advanced Clean Fleets Regulation would increase the number of ZE trucks by another 220,000 to a total of 640,000. However, in 2037, even after the implementation of the Advanced Clean Truck and Advanced Clean Fleets Regulations, about 480,000 heavy-duty combustion powered trucks will still be on the road. In this modified approach, staff would seek to upgrade these remaining heavy-duty combustion trucks to new or used ZE trucks rather than to trucks with cleaner combustion engines. For this measure, staff would implement regulatory strategies to achieve the goal of transitioning the remainder of the heavy-duty combustion fleet to ZE trucks. This measure was originally proposed as a public measure suggestion based on the input from community-based organizations and members of the public during the development of the 2022 State SIP Strategy. CARB staff decided to develop this public measure suggestion into a SIP measure commitment.

Drayage Trucks

Drayage trucks are subject to requirements under the ***Truck and Bus Regulation***, which requires 2010 Model Year or newer engines to continue entering ports and rail yards starting on January 1, 2023.

Under the ***Advanced Clean Fleets Regulation***, CARB is further strengthening emission controls for drayage fleets; all drayage trucks entering seaports and intermodal railyards would be required to be zero-emission by 2035. Advanced Clean Fleets Regulations controls drayage emissions through three main components:

- Zero-emission drayage truck requirements
  Drayage trucks will be required to start transitioning to zero-emission technology beginning in 2024, with full implementation by 2035
- Drayage Truck Registration Requirements
  All drayage trucks intending to begin or continue operations at a California seaport or intermodal railyard must be registered with CARB. Beginning in 2035, all trucks in the CARB Online System will be required to be zero-emission.
- Removing Combustion-Powered Drayage Trucks from Service
  Non-zero-emission (legacy) drayage trucks with a 2010 or newer model year engine may register in the CARB Online System on or before January 1, 2024. Beginning in 2024, all legacy drayage trucks must visit a seaport or intermodal railyard at least once each year to remain in the CARB Online System. Legacy drayage trucks 12 years old must begin reporting their mileage annually in 2025 and, can remain in the system until they reach their minimum useful life (either

800,000 miles or the engine is older than 18 years, whichever comes first). Beginning in 2025, legacy drayage trucks will be removed from the CARB Online System if they did not meet the annual visit requirement, OR if they have exceeded their minimum useful life requirements.

Solid Waste Collection Vehicles

For Solid Waste Collection Vehicles (SWCVs) operating in the South Coast, the South Coast AQMD requires under South Coast AQMD Rule 1193 that governmental agencies with 15 or more refuse collection vehicles use alternative fuel heavy-duty vehicles or engines that use compressed or liquefied natural ga, liquefied petroleum gas, methanol, electricity, fuel cells, or other advanced technologies that do not rely on diesel fuel. This rule began implementation in 2010, with requirements that new vehicles added to SWCV fleets (including purchases or leases) are rule-compliant vehicles. In 2020, the rule required that all vehicles used for refuse services are alternative-fueled or pilot ignition vehicles.[69] This program complements the suite of CARB regulations governing SWCVs.

CARB's ***Solid Waste Collection Vehicle Regulations*** were adopted in 2003 to reduce toxic diesel particulate matter (diesel PM) from approximately 12,000 diesel-fueled commercial and residential solid waste collection vehicle (SWCV) and recycling collection vehicles operated in California. The rule applies to all SWCVs of 14,000 pounds or more that run on diesel fuel, have engines in model years (MY) from 1960 through 2006, and collect waste for a fee. Additionally, SWCVs are subject to requirements under the ***Truck and Bus Regulation***, which requires 2010 Model Year or newer engines as of January 1, 2023.

The ***Advanced Clean Fleets Regulation***, approved by the CARB Board in April 2023, will accelerate ZEV adoption among solid waste collection vehicles. This regulation targets all state and local government fleets, and high priority fleets with 50 or more trucks or entities with trucks and $50 million in annual revenues. This effort is part of a comprehensive strategy to achieve a ZEV truck and bus fleet by 2045 everywhere feasible, and significantly earlier for certain well-suited market segments. The Advanced Clean Fleets Regulation would phase in ZEV requirements for different fleets, including State and local government fleets and those owned by or contracted with municipalities, including waste fleets. 100 percent of solid waste collection vehicle sales in California would be zero-emissions starting in 2036.

Public Agency and Utility Vehicles

California's ***Diesel Particulate Matter Control Measure for Municipality or Utility On-Road Heavy-Duty Diesel Fueled Vehicles*** (***Public Agency and Utility Regulation***) requires a municipality or utility that owns, leases or operates on-road diesel fueled vehicles with engine model year 1960 or newer and GVWR greater than 14,000 pounds to reduce PM2.5 emissions to 0.01 g/bhp-hr. This can be done by repowering, retrofitting, or retiring the vehicle. Implementation of the rule started in

[69] South Coast AQMD Rule Book, Rule 1193: Clean On-Road Residential and Commercial Refuse Collection Vehicles http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1193.pdf?sfvrsn=4

2007, with a compliance schedule based on the engine model year. Additionally, public agencies and utilities' fleets may be subject to requirements under the Truck and Bus Regulation.

The ***Advanced Clean Fleets Regulation***, approved by the CARB Board in April 2023, will accelerate ZEV adoption among public fleets. This regulation targets public fleets with 50 or more trucks or entities with trucks and $50 million in annual revenues. This effort is part of a comprehensive strategy to achieve a ZEV truck and bus fleet by 2045 everywhere feasible, and significantly earlier for certain well-suited market segments such as government fleets. The Advanced Clean Fleets Regulation will phase in ZEV requirements for different fleets, including requirements for State and local government fleets (including cities, counties, special districts, and other municipalities) to add only ZEVs to their fleets starting at 50 percent of new additions purchased in 2024 and 100 percent starting in 2027, or fleets may opt to phase-in ZEV requirement where a portion of the fleet must be zero-emission based on a pre-determined schedule. Small public fleets and those that are based in designated low population counties would begin with 100 percent ZEV additions starting in 2027.

Transit Agencies

Adopted in 2000, the ***Fleet Rule for Transit Agencies (Transit Fleet Rule)*** requires reductions in diesel PM and NOx emissions from urban buses and transit fleet vehicles and required future zero-emission bus purchases. Urban bus fleets were required to select either the diesel path or the alternative-fuel path. Transit agencies on the diesel path needed to demonstrate zero-emission buses, and to meet the zero-emission bus purchase requirements sooner, while agencies on the alternative-fuel path had to ensure that 85 percent of urban bus purchases were alternative fueled without a demonstration requirement. The Transit Fleet Rule was amended in 2004, and again in 2006. The 2006 amendments temporarily postponed the zero-emission bus purchase requirement (until 2011 and 2012, depending on the compliance path) and expanded the initial demonstration with a subsequent advanced technology demonstration phase. In 2009, CARB staff provided a technology update to the Board on the commercial readiness of zero-emission buses, and received Board direction to research and develop commercial readiness metrics to be used as criteria to initiate the zero-emission bus purchase requirement, and to conduct a technology assessment on the readiness of zero-emission bus technologies. U.S. EPA granted CARB a waiver of preemption for the Fleet Rule for Transit Agencies in 2013.[70] Additionally, transit fleets are subject to requirements under the Truck and Bus regulation.

In 2018, CARB adopted the ***Innovative Clean Transit (ICT) Regulation***, which requires all public transit agencies to gradually transition to a 100 percent zero-emission bus (ZEB) fleet. Beginning in 2029, 100 percent of new purchases by transit agencies must be ZEBs, with a goal for full transition by 2036. It applies to all transit agencies that own, operate, or lease buses with a gross vehicle weight rating (GVWR) greater than 14,000 lbs. It includes standard, articulated, over-the-road, double-decker, and cutaway

[70] U.S. EPA 2013, "California State Motor Vehicle Pollution Control Standards; Urban Buses; Request for Waiver of Preemption; Final Notice of Decision" Federal Register July 23, 2013 Volume 78, Number 141 pp. 44112-44117 https://www.gpo.gov/fdsys/pkg/FR-2013-07-23/pdf/2013-17700.pdf

buses. Under the ICT Regulation, requirements differ for large and small transit agencies. A transit agency is considered large if it operates at least 100 buses in annual maximum service in an urbanized area with a population of at least 200,000. However, if an agency operates in either the South Coast Air Basins or the San Joaquin Valley with more than 65 buses in annual maximum service, it is also considered a large transit agency. The ICT Regulation includes the following elements:

- A ZEB Rollout Plan required from each transit agency, approved by its Board, to show how it is planning to achieve a full transition to zero-emission technologies by 2040. Large transit agencies have to submit their Rollout Plan by July 1, 2020, and small transit agencies by July 1, 2023;
- ZEB purchases with various exemptions and compliance options to provide safeguards and flexibility to transit agencies;
- Low NO_x engine purchases, unless the transit buses are dispatched from NO_x Exempt areas;
- Use of renewable diesel or renewable natural gas for large transit agencies; and
- Reporting and record keeping requirements.

As shown in Table 15, ZEB purchase requirements begin in 2023 for large transit agencies and 2026 for small transit agencies, based on a percentage of new bus purchases each year that must be zero-emission. The ZEB purchase requirements for articulated, over-the-road, double-decker, or cutaway buses do not start until 2026 or later. These bus types remain exempt from the ZEB purchase requirements until they pass the Altoona testing.

Table 15: ZEB Purchase Schedule
(ZEB Percentage of Total New Bus Purchases)

Year	Large Transit	Small Transit
2023	25%	-
2024	25%	-
2025	25%	-
2026	50%	25%
2027	50%	25%
2028	50%	25%
2029	100%	100%

Last Mile Delivery

California's emission controls for last mile delivery vehicles (Class 3-7 heavy-duty delivery trucks used to deliver freight from warehouses and distribution centers to the final point of sale or use) are the most stringent in the country. ***Truck and Bus Regulation*** requires MY 2010 or equivalent engines by 2023.

Further increases in the stringency of last mile delivery fleets are anticipated under the ***Advanced Clean Fleets*** Regulation. Approved by CARB in April 2023, the Advanced Clean Fleets Regulation will accelerate ZEV adoption in the medium- and heavy-duty sectors by setting zero-emission requirements for fleets. This regulation high priority fleets with 50 or more trucks or entities with trucks and $50 million in annual revenues. This effort is part of a comprehensive strategy to achieve a ZEV truck and bus fleet by 2045 everywhere feasible, and significantly earlier for certain well-suited market segments. With this measure, staff anticipates bringing to the Board for consideration a regulation that would phase in ZEV requirements for different fleets, resulting in 100 percent of medium- and heavy-duty vehicle sales in California being zero-emissions starting in 2040.

Airport Shuttle Buses

The ***Zero-Emission Airport Shuttle Bus*** Regulation was adopted in 2019 and requires airport shuttle operators to transition to 100 percent zero-emission vehicle (ZEV) technologies. Airport shuttle operators must begin adding zero-emission shuttles to their fleets in 2027 and complete the transition to ZEVs by the end of 2035. The Regulation applies to airport shuttle operators who own, operate, or lease vehicles at any of the 13 California airports regulated under this rule (regulated airports), including Fresno Yosemite International Airport. Airport shuttle buses transport passengers between car parking lots, airport terminals, and airport car rental facilities. Airport shuttles that fall under the regulation include those with GVWR of 8,501 lbs or greater, which transport passengers to, from, or around a regulated airport, shuttles based or housed within 15 miles of a regulated airport that have round trip routes equal to or less than 30 miles, and shuttles with fixed destination routes that may include stops at locations such as rental car facilities, on-airport or off-airport parking, hotels, or other tourist destinations. (A fixed destination route is a predetermined route that transports passengers between the same locations, although the number of stops along the route may vary.)

Airport shuttle fleets must meet fleet ZEV requirements according to the compliance schedule in Table 16. After January 1, 2023, a fleet owner choosing to replace a ZEV in the existing fleet must replace it with another ZEV. Model year 2026 (and later) airport shuttles greater than 14,000 lbs (GVWR) must comply with the Zero-Emission Powertrain Certification Regulation. Reporting and record keeping requirements begin in 2022.

Table 16: Zero-Emission Airport Shuttle Regulation Requirements

Airport Shuttle Buses – Fleet ZEV Requirements	
Compliance Deadline	Percent of Fleet that Must be Zero-Emission
December 31, 2027	33%
December 31, 2031	66%
December 31, 2035	100%

School Buses

The ***Truck and Bus Regulation*** requires that all California school buses are equipped with diesel PM filters. Additionally, the ***School Bus Idling Airborne Toxic Control Measure*** (School Bus ATCM) limits bus and commercial motor vehicle idling near schools or at school bus destinations to only when necessary for safety or operational concerns. It has been in effect since July 16, 2003, and reduces emissions from more than 26,000 school buses that operate daily at or near schools. The program targets school buses, school pupil activity buses, youth buses, paratransit vehicles, transit buses, and heavy-duty commercial motor vehicles that operate at or near schools. In 2009, Senate Bill 124, Oropeza (SB 124) acknowledged and codified CARBs ATCM limiting school bus idling raising the minimum penalty for a violation of this rule from $100 to $300. The bill also clarifies local air district authority to enforce the State's school bus idling program. SB 124 became effective on January 1, 2010, and the existing regulation was revised to reflect this change.

While California's idling requirements for school buses are the most stringent in the nation, California does not currently have any proposed or current regulations that require electrification of the school bus fleet. New York State's enacted fiscal year 2022-2023 budget established a nation-leading commitment for all new school buses purchased to be zero emission by 2027 and all school buses in operation to be electric by 2035,[71] a mandate that was first introduced in New York Governor Kathy Hochul's 2022 State of the State Address.[72] Under the New York law, all school district purchases or leases of new vehicles for student transportation must be zero-emission by 2027. School districts can, upon request, be granted an extension for up to two years beyond the 2027 deadline, but all purchases and leases by school districts or transportation contractors will need to be electric by 2029. In 2035, when fully implemented, all school buses must be electric, including district-owned and leased vehicles.[73]

FUELS

In addition to new engine and in-use standards, cleaner burning fuels represent an important component in reducing emissions from on-road heavy-duty diesel trucks and buses. Cleaner fuel has an immediate impact in reducing emissions from the mobile source, and thus represent an important component in reducing NOx and diesel PM emissions from the on-road heavy-duty fleet. California's stringent air quality programs treat motor vehicles and their fuels holistically (as a system, rather than as separate components). As a result, CARB's fuels programs achieve significant reductions in criteria emissions from motor vehicles used in California.

CARB Diesel Fuel Regulations

The California diesel fuel program sets stringent standards for diesel fuel sold in California and ensures that in-use diesel engines continue to operate as cleanly as

[71] New York Senate Bill S8006C https://www.nysenate.gov/legislation/bills/2021/S8006
[72] 2022 New York State of the State Book https://info.aee.net/hubfs/2022StateoftheStateBookNY.pdf
[73] Rockefeller Institute of Government, November 2022 https://rockinst.org/blog/meeting-new-yorks-electric-school-bus-mandate-takeaways-from-the-2022-school-finance-symposium/

possible. CARB's Diesel Fuel Regulations have, over time, phased in more stringent requirements for fuel mixture specifications for aromatic hydrocarbons and sulfur (a precursor to formation of secondary PM), and have establish a lubricity standard which apply fuels used in on- and off-road applications in California. ***"CARB diesel" Specifications*** adopted in 1988 limited the allowable sulfur content of diesel fuel 500 parts per million by weight (ppmw), and the aromatic hydrocarbon content to 10 percent, and became effective in 1993.

In 2003, ***CARB's Ultra Low Sulfur Diesel (ULSD) Regulation*** increased the stringency of the sulfur content limits in to 15 ppm, which harmonized with the 1993 U.S. EPA regulation that also limited sulfur in on-road diesel fuels to the same level. Both the California and federal ULSD regulations began implementation in 2006. CARB's ULSD Regulation had an immediate impact in reducing emissions from the in-use on-road heavy-duty fleet, while also enabling the use of advanced emissions control technologies, including the use of catalyzed diesel particulate filters, NOx after-treatment, and other advanced after-treatment based emission control technologies that higher sulfur levels would have inhibit the performance of (at the time of CARB's ULSD rulemaking, the average sulfur content of California diesel was approximately 140 ppmw).

Beyond the current fuels control program, CARB committed in the 2016 State SIP Strategy to develop a ***Low Emission Diesel*** Measure that will require diesel fuel providers to steadily decrease criteria pollutant emissions from their diesel products. The use of low-emission diesel in on-road vehicles and off-road equipment will reduce tailpipe NOx and PM emissions, in addition to other criteria pollutants. Some studies carried out to date on hydrotreated vegetable oil have reported NOx emission reductions of 6 percent to 25 percent and PM emission reductions of 28 percent to 46 percent, depending on the types of fuels, drive cycles tested, and diesel engines used. This standard is anticipated to both increase consumption of low-emission diesel fuels, and to reduce emissions from conventional fuels. This measure is anticipated to provide NOx benefits predominately from legacy (pre-2010) on-road heavy-duty vehicles, off-road engines, stationary engines, portable engines, marine vessels and locomotives, as well as NOx and diesel PM benefits in potentially all model year off-road engines, stationary engines, portable engines, marine vessels and locomotives. Interstate vehicles, even those registered out-of-State but operating on CARB diesel blended with low-emission diesel, are also anticipated to provide emission reduction benefits.

Controlling Criteria Emissions from Renewable Fuels

The ***Low Carbon Fuel Standard (LCFS) and Alternative Diesel Fuel (ADF) Regulations,*** as amended in 2014, work together to reduce the carbon intensity of the California fuel supply. The regulations also limit criteria emissions from alternative fuels and/or alternative fuel mix blends (a mix of fuels made from renewable feedstocks, which are then blended with conventional gasoline or diesel).

STEP 2(B): OTHER STATES' AND NONATTAINMENT AREAS' ON-ROAD MEDIUM- AND HEAVY-DUTY CONTROL MEASURES

Table 17 summarizes the most stringent control measures currently in use in any state or nonattainment that have been identified and discussed for on-road heavy-duty vehicles. Each of the measures identified in this table are discussed in more detail in this section, below.

Table 17: Comparison of Stringency – Heavy-Duty Measures

CARB Control Programs Compared to Federal Standards and Control Programs in Other States and Nonattainment Areas

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
New Engine Standards			
New Vehicle and Engine Standards: Zero-Emission Requirements	Advanced Clean Trucks (CARB)	The Advanced Clean Truck Regulation is part of a holistic approach to accelerate a large-scale transition of zero-emission medium-and heavy-duty vehicles from Class 2b to Class 8. The regulation has two components including a manufacturer sales requirement, and a reporting requirement: • Zero-emission truck sales: Manufacturers who certify Class 2b-8 chassis or complete vehicles with combustion engines would be required to sell zero-emission trucks as an increasing percentage of their annual California sales from 2024 to 2035. By 2035, zero-emission truck/chassis sales would need to be 55% of Class 2b – 3 truck sales, 75% of Class 4 – 8 straight truck sales, and 40% of truck tractor sales.	CARB is leading the nation on the development and penetration of on-road heavy-duty ZEVs through the Advanced Clean Trucks Regulation Reg teams – what other States have adopted / are in the process of adopting the ACT regulation? MA, NJ, NY, OR, VT, & WA have adopted … others? ME has begun rulemaking process, where do CO, CT, DC, HI, MD, NC, OR, PA, RI, VA, stand? The following states have adopted ACT: MA, NJ, NY, OR, VT, and WA. Some other states are considering adoption. NC has an executive order directing state officials to begin adopting the ACT rule.
New Vehicle and Engine Standards: Heavy-duty internal combustion engine emission standards (mandatory standards)	Mandatory Heavy-Duty vehicle and engine emission standards (CARB and U.S. EPA) Heavy-Duty Omnibus Regulation (CARB)	California's emissions standards for on-road heavy-duty vehicles are the most stringent in the nation. CARB's current emission standards for heavy-duty engines (NOx and PM) are set at the same level of stringency as Federal standards for MY 2010– 2023 engines. With the Heavy-Duty Omnibus regulation, CARB has further increased the stringency of controls for MY 2024 and subsequent engines by lowering California NOx and PM emission standards on existing regulatory cycles as well as a new NOx standard on a new low load certification cycle. The NOx standards would be cut to about 75 percent below current standards beginning in 2024 and 90 percent below current standards in 2027. The limits are for MY 2024 - 2026: • NOx: 0.050 g/bhp-hr	No other state has more stringent exhaust emission standards than California. Current CARB and U.S. EPA limit exhaust emissions to same levels (MY 2010 – 2023) • NOx: 0.20 g/bhp-hr • PM: 0.01 g/bhp-hr Five other States have also adopted the Omnibus regulation (MA, NY, OR, WA and VT). In MYs 2024-2026, California's standards will exceed the stringency of Federal standards, which are currently at 0.20 g/bhp-

<table>
<tr><th>Type of Control Measure</th><th>Most Stringent Control Program Identified</th><th>Summary of Findings from Analysis</th><th>Other Jurisdiction(s) Analyzed</th></tr>
<tr><td colspan="4">On-Road Heavy-Duty Vehicles</td></tr>
<tr><td></td><td></td><td>• PM: 0.005 g/bhp-hr

For MY 2027-2030:
• NOx: 0.020 g/bhp-hr @ miles ≤ 435,000
0.035 g/bhp-hr @ 435,000 < miles ≤ 600,000
• PM: 0.005 g/bhp-hr

For 2031 and Subsequent MYs:
• NOx : 0.020 g/bhp-hr @ miles ≤ 435,000
0.040 g/bhp-hr @ 435,000 < miles ≤ 800,000
• PM: 0.005 /bhp-hr

In December 2022, U.S. EPA finalized new emissions standards for federally-certified vehicles beginning in 2027, though these are less stringent than those included in CARB's Heavy-Duty Omnibus Regulation: For MY 2027 and later years, federal certification limits will be set to 0.035 g/hp-hr for NOx and 0.005 g/hp-hr for PM</td><td>hr for NOx and 0.01 g/bhp-hr for PM, and will strengthen to 0.050 g/bhp-hr for NOx and 0.005 g/bhp-hr for PM.</td></tr>
<tr><td>New Vehicle and Engine Standards: Optional heavy-duty internal combustion engine emission standards</td><td>Optional Heavy-Duty Low NOx Emission Standards (CARB)

Omnibus Regulation (CARB)</td><td>CARB's optional standards accelerate the pace of innovation and development of cleaner engine technologies by certifying engines that go beyond the stringency of existing standards. Starting in 2015, engine manufacturers could choose to certify to three optional NOx emission standards of 0.1 g/bhp hr, 0.05 g/bhp-hr, and 0.02 g/bhp-hr (i.e., 50 percent, 75 percent, and 90 percent lower than the existing mandatory standard of 0.2 g/bhp-hr). Together with the mandatory standards that harmonize with federal emission requirements, this program makes California's suite of HD engine emission controls the most stringent in the nation.

The Heavy-Duty Omnibus Regulation will lower the optional Low-NOx Emission Standards to 0.020 g/bhp-hr for MY 2024-26 and to 0.010 g/bhp-hr for MY 2027 and later.</td><td>California is the only state with optional exhaust emission standards for heavy-duty engines that exceed the stringency of U.S. EPA requirements.</td></tr>
<tr><td>New Vehicle and Engine Standards: Warranty Requirements and Useful Life</td><td>California Emission Control System Warranty Regulations and Maintenance Provisions (CARB)

Omnibus Regulation (CARB)</td><td>For Model Years 2022 and later, U.S. EPA warranty provisions cover 100,000 miles, or 5 years / 3,000 hours, for Class 4 – 8 trucks; California's more stringent warranty provisions cover:
• Class 8: 350,000 miles, or 5 years
• Class 6 – 7: 150,000 miles, or 5 years
• Class 4 – 5: 110,000 miles, or 5 years

CARB Useful Life:<table><tr><th>Model Year</th><th>Useful Life (miles)</th></tr></table></td><td>Currently, no other state has more stringent warranty requirements than California. California is the only state with the authority to initially adopt and enforce emission standards and test procedures for new motor vehicles and new motor vehicle engines that are more stringent than federal emission standards and test procedures.

For MY 2022 – 2026, CARB's warranty requirements are more stringent than Federal standards, and California's useful life requirements align with federal requirements. Under the 2021 Omnibus Regulation, California warranty and useful life</td></tr>
</table>

<table>
<tr><th>Type of Control Measure</th><th>Most Stringent Control Program Identified</th><th>Summary of Findings from Analysis</th><th>Other Jurisdiction(s) Analyzed</th></tr>
<tr><td colspan="4">On-Road Heavy-Duty Vehicles</td></tr>
<tr><td></td><td></td><td>
<table>
<tr><th></th><th>Class 4 – 5 Diesel</th><th>Class 6 – 7 Diesel</th><th>Class 8 Diesel</th><th>Heavy-Duty Otto</th></tr>
<tr><td>Current – 2026</td><td>110,000 miles 10 years</td><td>185,000 miles 10 years</td><td>435,000 miles 10 years 22,000 hours</td><td>110,000 miles 10 years</td></tr>
<tr><td>2027–2030</td><td>190,000 miles 12 years</td><td>270,000 miles 11 years</td><td>600,000 miles 11 years 30,000 hours</td><td>155,000 miles 12 years</td></tr>
<tr><td>2031 and subsequent model years</td><td>270,000 miles 15 years</td><td>350,000 miles 12 years</td><td>800,000 miles 12 years 40,000 hours</td><td>200,000 miles 15 years</td></tr>
</table>
For older MY trucks and engines, both U.S. EPA and CARB require that heavy-duty vehicles meet emission standards throughout their useful life periods of 5 years / 100,000 miles (GVWR > 14,000 lbs.)</td><td>requirements are at least as stringent as federal requirements for My 2027 – 2031+.</td></tr>
<tr><td>New Vehicle and Engine Standards: OBD Requirements</td><td>Heavy-Duty OBD (CARB)</td><td>CARB and federal OBD regulations for heavy-duty vehicles generally align for MY2013 and newer engines, although CARB's program has been amended to be more stringent than U.S. EPA's for certain vehicle types. California OBD requirements are overall at least as stringent as applicable federal requirements. California OBD fault detection requirements are at least as stringent if not more stringent than U.S. EPA requirements. However in 2022, U.S. EPA updated their OBD requirements applicable to 2027 and subsequent model years to delete some California requirements and add some emission control system data parameters to be provided on demand and in the driver display.</td><td>No other state has more stringent OBD requirements than California</td></tr>
</table>

CARB Control Program MSM Analysis
for the SCAQMD 2024 12 µg/m^3 annual PM2.5 Plan

<table>
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<tr><td colspan="4">On-Road Heavy-Duty Vehicles</td></tr>
<tr><td colspan="4">In-Use Emission Controls</td></tr>
<tr><td>In-Use Emissions Controls:
I/M program (opacity limits)</td><td>Periodic Smoke Inspection Program (PSIP) (CARB)</td><td>California's in-use emission controls including opacity limits are the most stringent in the nation. The 2018 Amendments to the Periodic Smoke Inspection Program (PSIP) require all California-based fleets of two or more heavy-duty diesel vehicles over 6,000 pounds GVWR with engines over four years old are required to perform annual smoke opacity tests (1998 and newer diesel vehicles between 6,000–14,000 pounds GVWR subject to biennial smog check are not subject to PSIP).

Allowable levels of Smoke Opacity are shown below:<table><tr><td colspan="2">Engines Equipped with a Diesel Particulate Filter (DPF)</td></tr><tr><td colspan="2">5% Opacity Limit</td></tr><tr><td colspan="2">Pre-2007 Model Year (MY) Engines without a DPF</td></tr><tr><td>1997– 2006 MY Engines</td><td>20% Opacity Limit</td></tr><tr><td>1991–1996 MY Engines</td><td>30% Opacity Limit</td></tr><tr><td>Pre-1991 MY Engines</td><td>40% Opacity Limit</td></tr><tr><td colspan="2">Engines Equipped with a Level 2 Verified Diesel Emission Control Strategy (VDECS)</td></tr><tr><td colspan="2">20% Opacity Limit</td></tr><tr><td colspan="2">Two-Engine Cranes Driven by a non-DPF Off-Road Engine</td></tr><tr><td colspan="2">40% Opacity Limit</td></tr></table></td><td>New Jersey's opacity limits range from 40% - 20%. California's in-use emission controls, including opacity limits, are the most stringent in the nation.</td></tr>
<tr><td>In-Use Emissions Controls:
I/M program (Testing)</td><td>Heavy-Duty Vehicle Inspection Program (HDVIP) (CARB)

Periodic Smoke Inspection Program (PSIP) (CARB)

The Heavy-Duty Omnibus Regulation (CARB)

The Heavy-Duty Inspection and Maintenance Program (HD I/M) (CARB)</td><td>California's in-use testing program (including the HD I/M, HDVIP and PSIP regulations) is the most stringent in the nation, with further increases in stringency going into effect in 2024.

The Heavy-Duty Omnibus Regulation revised the heavy-duty in-use testing program to make it more effective in ensuring compliance with the in-use emission standards over a broader range of vehicle operation, and to better represent heavy-duty vehicle operations in real world conditions. The Omnibus regulation established clearer criteria for engine family pass/fail determination, and requires on-board diagnostic (OBD) data during testing to verify the condition of the test vehicle and sensors. These amendments apply to 2024 and subsequent model year engines, and replace the current NTE-based methodology with a new three-bin moving average windows-based methodology.

Under the Heavy-Duty Inspection and Maintenance Program (HD I/M), heavy-duty vehicles registered in California will also be required to demonstrate annual compliance with HD I/M program requirements in order to register with the Department of Motor Vehicles. Beginning in January 2023, CARB is using roadside emissions monitoring devices (REMD) to screen for vehicles that may have high emissions. Vehicles flagged as potential high emitters may be required to undergo follow-up vehicle compliance testing to ensure they are operating with properly</td><td>Three other states also test OBD in heavy-duty vehicles (MA, NJ, and WI), but none aside from California are currently enforcing on OBD scans for vehicles >14,000 lb. GVWR. Additionally, they do not control emissions from out-of-state trucks, or include the potential use of telematics like CARB.</td></tr>
</table>

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
		functioning emissions control systems. Upon full implementation of HD I/M periodic compliance testing, nearly all vehicles will be required to undergo twice per year testing with results submitted to CARB. Three years after the start of HD I/M periodic compliance testing, on board diagnostics (OBD) equipped vehicles will be required to undergo testing four times per year. On-road agricultural vehicles and California-registered motorhomes only will be required to undergo testing once per year.	
In-Use Emissions Controls: Idling requirements	Heavy-Duty Diesel Vehicle Idling Reduction Program (CARB) Heavy-Duty Omnibus Regulation (CARB)	California's idling requirements and comprehensive program for on-road heavy-duty vehicles limits idling time to five minutes, and requires that MY 2008 and newer engines are equipped to automatically shut down after five minutes of idling. While other jurisdictions have adopted similar idling time limits requirements – some with more stringent time limits than CARB – none surpassed the stringency of California's program in effect, because emission performance requirements for idle reduction technologies are unique to California's program. The Heavy-Duty Omnibus Regulation reduces idling limits for heavy-duty diesel vehicles from 30g/hr to 10g/hr in MY 2024 – 2026 engines, and to 5 g/hr in MY 2027+ engines.	Areas with more stringent time limits: • 2 minute restrictions, no exemptions: Philadelphia, PA • 2 minute restrictions, some exemptions: Salt Lake City and Salt Lake County, UT • 3 minute restrictions, some exemptions: CT, DC, City of Ketchum (ID), New York City (NY), the Village of Larchmont (NY), the Village of Mamaroneck (NY), the County of Westchester (NY), Park City (UT), and the City of Birmingham (VT) Areas with less stringent time limits: • 3 minute restrictions, some exemptions DE, Chicago (IL), NJ, Town of Mamaroneck (NY), and Rockland County (NY)
In-Use Emissions Controls: Fleet Rules	Truck and Bus Regulation (CARB) Advanced Clean Fleets Regulation (CARB) Future Measure: *Zero-Emission Trucks Measure (CARB)*	California's in-use emission controls for on-road heavy-duty vehicles are the most stringent in the nation. CARB's Truck and Bus regulation is the most comprehensive and stringent mandatory heavy-duty fleet turnover rule in the nation, affecting approximately one million inter- and intra-state on-road diesel vehicles. The regulation applies to nearly all privately or federally owned diesel-fueled trucks and buses > 14,000 lbs., GVWR, including on-road and off-road agricultural yard goats, cargo handling equipment, drayage trucks, solid waste collection vehicles, and school buses. Its phased-in requirements mandate diesel particulate filters in early years, eventually requiring vehicles to fully upgrade to newer, cleaner engines that meet MY 2010 engine equivalent emissions levels when fully implemented in 2023. Approved by CARB in April 2023, the Advanced Clean Fleets Regulation accelerates ZEV adoption in the medium-to heavy-duty sectors and for light-duty package delivery trucks by setting zero-emission requirements for fleets. This regulation targets drayage trucks, public fleets, and other high priority fleets with 50 or more trucks or entities with trucks and $50 million in annual revenues. This effort is part of a comprehensive strategy to achieve a ZEV truck and bus fleet by 2045 everywhere feasible, and significantly earlier for certain well-suited market segments such as last mile delivery, drayage, and government fleets. The	No other state requires diesel particulate filters (DPF) and MY 2010 + equivalent engines as a mandatory fleet rule affecting nearly the entire on-road diesel fleet No other state has zero-emission requirements for heavy-duty vehicle fleets

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
		regulation will phase in ZEV requirements for different fleets, including components as follows: • Beginning January 1, 2024, all additions to High Priority and Federal fleets must be ZEVs, and all combustion vehicles must be removed from the California fleet at the end of their useful life, or fleets may opt to phase-in ZEV requirement where a portion of the fleet must be zero-emission based on a pre-determined schedule. • State and local government fleets including cities, counties, special districts, and other municipalities would be required to add only ZEVs to their fleets starting at 50 percent of new additions in 2024 and 100 percent starting in 2027 or fleets may opt to phase-in ZEV requirement where a portion of the fleet must be zero-emission based on a pre-determined schedule. Small public fleets or those that are based in designated low population counties would begin with 100 percent ZEV additions starting in 2027. • Beginning January 1, 2024, any truck added to drayage service would need to be a ZEV. All drayage trucks entering seaports and intermodal railyards would be required to be zero-emission by 2035; and • 100 percent of medium- and heavy-duty vehicle sales in California would be zero-emissions starting in 2036. Under the recently-approved regulation and the ACT regulation, the number of medium- and heavy-duty ZEVs operating in California will be about 1.7 million by 2045. The future Zero-Emission Trucks measure would accelerate the number of zero-emissions (ZE) trucks beyond existing measures (including the Advanced Clean Fleets regulation). This measure is anticipated to be implemented through one of two potential options: • Option A would use market signal tools, if given authority to implement differentiated registration fees, restrictions or fees for heavy-duty combustion trucks entering low/zero-emission zones, and/or indirect source rules to establish ZE zones by 2035. • Option B would likely be pursued if CARB is unable to implement the strategies and/or if new authorities outlined in Option A do not come to fruition. If so, CARB may need to implement an inflexible requirement for all fleets to phase-in ZEVs and to remove legacy trucks from service in California. *(Note: CARB has committed to pursue the Zero-Emission Trucks measure, but this measure has yet to be proposed to the Board for approval/adoption)*	

CARB Control Program MSM Analysis
for the SCAQMD 2024 12 µg/m^3 annual PM2.5 Plan

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
In-Use Emissions Controls: Fleet Rules (Drayage Trucks)	Truck and Bus Regulation (CARB) Advanced Clean Fleets Regulation (CARB)	California's in-use emission controls for drayage trucks are the most stringent in the nation. The Truck and Bus Regulation requires 2010 Model Year or newer engines at ports and rail yards starting in 2023. Approved by CARB in April 2023, the Advanced Clean Fleets (ACF) Regulation, CARB is further strengthening emission controls for drayage fleets; all drayage trucks entering seaports and intermodal railyards would be required to be zero-emission by 2035; ACF controls drayage emissions through three main components: • Zero-emission drayage truck requirements Drayage trucks will be required to start transitioning to zero-emission technology beginning in 2024, with full implementation by 2035 • Drayage Truck Registration Requirements All drayage trucks intending to begin or continue operations at a California seaport or intermodal railyard must be registered with CARB. Beginning in 2035, all trucks in the CARB Online System will be required to be zero-emission. • Removing Combustion-Powered Drayage Trucks from Service Non-zero-emission (legacy) drayage trucks with a 2010 or newer model year engine may register in the CARB Online System on or before January 1, 2024,. Beginning in 2024, all legacy drayage trucks must visit a seaport or intermodal railyard at least once each year to remain in the CARB Online System. Legacy drayage trucks 12 years old must begin reporting their mileage annually in 2025 and, can remain in the system until they reach their minimum useful life (either 800,000 miles or the engine is older than 18 years, whichever comes first). Beginning in 2025, legacy drayage trucks will be removed from the CARB Online System if they did not meet the annual visit requirement, OR if they have exceeded their minimum useful life requirements.	No other jurisdiction mandates more stringent fleet requirements for drayage trucks.
In-Use Emissions Controls: Fleet Rules (Solid Waste Collection Vehicles)	Solid Waste Collection Vehicle Regulations (CARB) Truck and Bus Regulation (CARB) Advanced Clean Fleets Regulation (CARB)	California's in-use emissions controls for solid waste collection vehicles (SWCVs) are the most stringent in the nation. Compared to New York City's program, CARB's Solid Waste Collection Vehicles regulation limits PM emissions at approximately the same level of stringency. However, SWCV's with 2007-2009 engines were also subject to more stringent 2010 engine requirements under Truck and Bus, however, the overall level of emission controls are more stringent in California than any other jurisdiction. Approved by CARB in April 2023, the Advanced Clean Fleets Regulation accelerates ZEV adoption among solid waste collection vehicles. This regulation targets all state and local government fleets and high priority fleets with 50 or	New York City (NY) requires that at least 90 percent of the ~8,300 qualifying privately and publicly-owned SWCVs meet the U.S. EPA's 2007 diesel standard for PM. Comparatively, CARB controls ~12,000 SWCVs (MYs 1960 through 2006) at approximately the same level of PM control for all trucks (i.e. equivalent to the 2007 MY standard of 0.01 g/bhp-hr).

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
		more trucks or entities with trucks and $50 million in annual revenues. This effort is part of a comprehensive strategy to achieve a ZEV truck and bus fleet by 2045 everywhere feasible, and significantly earlier for certain well-suited market segments. The regulation will phase in ZEV requirements for different fleets, including State and local government fleets and those owned by or contracted with municipalities, including waste fleets. 100 percent of solid waste collection vehicle sales in California would be zero-emissions starting in 2036.	
In-Use Emissions Controls: Fleet Rules (Public fleets)	Public Agency and Utility Regulation (CARB) Truck and Bus Regulation (CARB) Advanced Clean Fleets Regulation (CARB)	California's in-use emissions controls for public fleets are the most stringent in the nation. CARB's Public Agency and Utility Regulation requires similar stringency in PM emissions limits as the Boston, MA program; because some utility fleets are also subject to more stringent requirements under Truck and Bus, the overall level of emission controls are more stringent in CA than any other jurisdiction. Approved by CARB in April 2023, the Advanced Clean Fleets Regulation accelerates ZEV adoption among public fleets. This regulation targets all public fleets in California. This effort is part of a comprehensive strategy to achieve a ZEV truck and bus fleet by 2045 everywhere feasible, and significantly earlier for certain well-suited market segments such as last mile delivery, drayage, and government fleets. The regulation will phase in ZEV requirements for different fleets. State and local government fleets – including cities, counties, special districts, and other municipalities – would be required to add only ZEVs to their fleets starting at 50 percent of new purchases in 2024 and 100 percent starting in 2027 or fleets may opt to phase-in ZEV requirement where a portion of the fleet must be zero-emission based on a pre-determined schedule. Small public fleets and those that are based in designated low population counties would begin with 100 percent ZEV additions starting in 2027.	The city of Boston (MA) requires by 2018 all pre-2007 diesel vehicles and equipment not previously retrofit to be controlled to achieve emission reductions of at least 85 percent (approximately equivalent to the 2007 PM standard of 0.01 g/bhp-hr). Comparatively, CARB limits are set equivalent to the 2007 MY standard of 0.01 g/bhp-hr for engine MY 1960 or newer, GVWR > 14,000 lbs.
In-Use Emissions Controls: Fleet Rules (Transit fleets)	Transit Fleet Rule (CARB) Innovative Clean Transit Regulation (CARB)	California's in-use emission controls for transit vehicles are the most stringent in the country. The Transit Fleet Rule requires emission reductions (PM and NOx) from urban buses and transit fleet vehicles, and required future zero-emission bus purchases. The Innovative Clean Transit (ICT) Regulation requires all public transit agencies to gradually transition to a 100 percent zero-emission bus (ZEB) fleet. Beginning in 2029, 100% of new purchases by transit agencies must be ZEBs, with a goal for full transition by 2036.	No other jurisdiction mandates more stringent fleet requirements for transit fleets.
In-Use Emissions Controls: Fleet Rules (Last mile delivery trucks)	Truck and Bus Regulation (CARB)	California's in-use emission controls for last mile delivery vehicles (Class 3-7 heavy-duty delivery trucks used to deliver freight from warehouses and distribution centers to the final point of sale or use) are the most stringent in the nation. Truck and Bus requires MY 2010 or equivalent engines for Class 4 – 8 engines by 2023.	No other jurisdiction mandates more stringent fleet requirements for last mile delivery trucks.

CARB Control Program MSM Analysis
for the SCAQMD 2024 12 µg/m^3 annual PM2.5 Plan

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
	Advanced Clean Fleets Regulation (CARB)	Approved by CARB in April 2023, the Advanced Clean Fleets Regulation accelerates ZEV adoption in the medium- to heavy-duty sectors and for light-duty package delivery trucks by setting zero-emission requirements for high priority fleets with 50 or more trucks or entities with trucks and $50 million in annual revenues. This effort is part of a comprehensive strategy to achieve a ZEV truck and bus fleet by 2045 everywhere feasible, and significantly earlier for certain well-suited market segments. The regulation will phase in ZEV requirements for different fleets, resulting in 100 percent of medium- and heavy-duty vehicle sales in California being zero-emissions starting in 2036.	
In-Use Emissions Controls: Fleet Rules (Airport shuttle buses)	Truck and Bus Regulation (CARB) Zero-Emission Airport Shuttle Bus Regulation (CARB)	California's in-use emission controls for airport shuttle buses (vehicles used to transport passengers between car parking lots, airport terminals, and airport car rental facilities) are the most stringent in the nation. The Truck and Bus Regulation requires MY 2010 or equivalent engines by 2023. The Zero-Emission Airport Shuttle Bus Regulation requires airport shuttle operators to transition to 100 percent zero-emission vehicle (ZEV) technologies. Airport shuttle operators must begin adding zero-emission shuttles to their fleets in 2027, and complete the transition to ZEVs by the end of 2035. The regulation applies to airport shuttle operators who own, operate, or lease vehicles at any of the 13 California airports regulated under this rule (regulated airports), including the Fresno Yosemite International Airport.	No other jurisdiction mandates more stringent fleet requirements for airport shuttle buses.
In-Use Emissions Controls: Fleet Rules (School Buses)	Truck and Bus Regulation (CARB) School Bus Idling Airborne Toxic Control Measure (CARB) Omnibus Regulation (CARB) School Bus Incentive Program (CARB)	California's in-use emission controls for school buses are among the most stringent in the nation. The Truck and Bus regulation requires that all school buses are equipped with PM filters. Since 2003, California has also limited bus and vehicle idling time near schools or at school bus destinations through the School Bus ATCM, reducing emissions from >26,000 school buses operating daily at or near schools. Under the Omnibus Regulation, idling limits for diesel heavy-duty vehicles will be reduced from 30 g/hr currently to 10 g/hr in MY 2024 and to 5 g/hr in MY 2027. CARB has also used incentive funds as a key component of the strategy to reduce emissions from the school bus fleet. Over the past two decades, CARB's School Bus Incentive Program has invested over $1.2 billion to date to clean up old, higher-polluting school buses, which has supported about 1,800 zero emission school buses. Under this program, California leads the nation in deployment of zero emission school buses; by comparison, 888 zero emission school buses have been awarded, ordered, or deployed across the U.S. outside of California.	Colorado (CO) controls emissions from school buses through a School Bus Retrofit Program funded by DERA Grants from U.S. EPA. This voluntary program began in 2009, and controls PM emissions through retrofits. CARB staff is unaware of any other jurisdictions that mandate retrofits. New York State requires all new school buses purchased to be zero emission by 2027, and all school buses in operation to be electric by 2035.

CARB Control Program MSM Analysis
for the SCAQMD 2024 12 µg/m^3 annual PM2.5 Plan

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
Fuels Programs			
Fuels Standards: Diesel Standards	CARB Diesel Fuel Regulations and Ultra Low Sulfur Diesel (CARB) Future Measure: *Low Emission Diesel measure (CARB)*	California's fuel standards for diesel are the most stringent in the nation. CARB Diesel Fuel Regulations include stringent requirements for fuel mixture specifications for aromatic hydrocarbons and sulfur, and have establish a lubricity standard and applies to sales of fuel used in on-road vehicles and off-road vehicles and locomotives in California. CARB's ULSD program reduces NOx and PM emissions significantly relative to U.S. EPA requirements, providing approximately 7 percent more NOx reductions and 25 percent more dPM reductions than federal diesel. CARB is anticipated to further increase the stringency of controls on criteria pollutant emissions diesel products. *(NOTE: CARB has committed to pursue the Low Emission Diesel measure, but it has not yet been proposed to the Board for approval/adoption.)*	No state requires cleaner burning diesel than California. The California diesel fuel regulations exceed federal requirements in stringency. CARB staff are aware of only one other state, Texas, who has a boutique diesel fuel program that is approved into the SIP. An independent analysis of The Texas Low Emission Diesel program (TxLED) showed that the TxLED fuel emissions performance does not provide as significant of emission reduction benefits as the California specifications.
Fuels Standards: Alternative Fuel Standards (Diesel substitutes)	Low Carbon Fuel Standard (CARB) Alternative Diesel Fuel Regulation (CARB)	California's fuel standards for diesel substitutes are the most stringent in the nation. The Low Carbon Fuel Standard and Alternative Diesel Fuel regulations work together to reduce the carbon intensity of the California fuel supply while requiring limits on criteria emissions from alternative fuels and/or alternative fuel mix blends.	No other state has set as stringent of criteria emission requirements on alternative fuels and alternative fuel blends than California. For low carbon fuel/clean fuel programs: • Oregon, and Washington have low carbon fuel standard programs, California participates in the Pacific Coast Collaborative with these states, and British Columbia. • Other states and countries that are considering a clean fuel regulation: NY, MI, MN, NM, VT, IL, MA.

NEW HEAVY-DUTY VEHICLE AND ENGINE STANDARDS

Heavy-duty engine emission standards

CARB's truck engine standards for on-road heavy-duty engines are consistent with the most stringent of any other area in the nation. CARB's current heavy-duty engine emission standards (MY 2010 - 2023) set exhaust emission standards for PM2.5 at 0.01 g/bhp-hr and NOx at 0.20 g/bhp-hr. This aligns with the applicable federal standards set by U.S. EPA, which are also set at the same levels of stringency.[74]

With the adoption and implementation of the Heavy-Duty Omnibus Regulation, CARB will further increase the stringency of these requirements to reduce NOx exhaust emissions standards to levels 90 percent lower than the current mandatory standard (for MY 2027 – 2030, mandatory emissions standards will be set to 0.020 g/bhp-hr at miles ≤ 435,000, and 0.035 g/bhp-hr at 435,000 - 600,000 miles). Massachusetts, New York, Oregon, Washington, and Vermont have also committed to adopt CARB's Omnibus Regulation. CARB's standards will exceed the stringency of Federal standards in MY 2024 – 2031.

In December 2022, U.S. EPA finalized new emissions standards for federally-certified vehicles beginning in 2027, though these are less stringent than those included in CARB's Heavy-Duty Omnibus Regulation: For MY 2027 and later years, federal certification limits will be set to 0.035 g/hp-hr for NOx and 0.005 g/hp-hr for PM.

In December 2022, U.S. EPA finalized their regulation, "Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards", which sets stronger NOx emission standards for MY 2027 and later heavy-duty vehicles and engines. For MY 2027 and later years, federal limits will be set to 0.05 g/bhp-hr for NOx and 0.005 g/bhp-hr for PM. Like the California standards, the new federal standards will also require lower NOX emissions over a much wider range of testing conditions both in the laboratory and when engines are operating on the road. Further, the regulation includes longer useful life periods, as well as significant increases in the emissions-related warranty periods.

As most Class 7 and 8 vehicles operating in California have been originally purchased outside of the State and are thus covered by U.S. EPA, rather than CARB standards, federal action is critical to achieving the needed emission reductions for the South Coast and other California nonattainment areas to meet U.S. EPA's air quality standards. However, U.S. EPA's recently finalized Clean Trucks Plan[75] is less stringent than the options previously suggested by U.S. EPA and CARB's Heavy-Duty Omnibus Regulation. Given the need for deep emissions reductions and the benefits of consistency in this area given the multiple jurisdictions in which trucks are purchased and used, CARB will advocate to align the federal CTP with CARB's Omnibus Regulations to the maximum degree possible.

[74] U.S. EPA 2016 "Heavy-Duty Highway Compression-Ignition Engines and Urban Buses: Exhaust Emission Standards" https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P100O9ZZ.pdf accessed May 1, 2018.
[75] U.S. EPA 2023 "Clean Trucks Plan" https://www.epa.gov/regulations-emissions-vehicles-and-engines/clean-trucks-plan accessed August 2, 2023.

U.S. EPA has also released two additional steps in their CTP, including a proposal for heavy-duty GHG standards for MY 2027 and later, under their "Phase 3" regulation, and multipollutant standards for light and medium-duty vehicles for MY 2027 and later. [76] U.S. EPA has issued final decisions in 2023 regarding several California waiver requests for California's heavy-duty vehicle and engine emission standards, including the 2018 Heavy-Duty Warranty Amendments, the Advanced Clean Truck (ACT) Regulation, the Zero-Emission Airport Shuttle Bus Regulation, and the Zero-Emission Powertrain Certification Regulation.[77] U.S. EPA has also signaled that they intend to issue a final decision on the waiver request for the Heavy-Duty Omnibus Regulation this year.[78] CARB will continue to call on U.S. EPA to move expeditiously in developing these requirements in recognition of the critical public health benefits they will provide.

Optional engine emission standards

To achieve further reductions and incentivize ongoing development of increasingly more efficient engine technologies, CARB has also provided since 2015 certification to optional emission standards at levels 50 percent, 75 percent, and 90 percent cleaner than currently mandated emission standards. This allows CARB and local air districts to preferentially incentivize and fund the purchase of cleaner trucks and engines than would have otherwise met the mandatory standard. CARB staff is unaware of any other state with a similar control program. With the Omnibus Regulation, the optional emission standards lower further, from current levels of 0.10 – 0.02 g/bhp-hr (through MY 2024), to 0.010 g/bhp-hr for MY 2027+.

Zero-Emission Trucks

CARB's Advanced Clean Truck Regulation has also been adopted by several states, including Massachusetts, New Jersey, New York, Oregon, Vermont, and Washington, while Maine has begun the rulemaking process to adopt.[79] Some other states are also considering adoption of the rule, while North Carolina has an executive order directing state officials to begin adopting the Advanced Clean Truck rule. Together with California, these states comprise approximately a quarter of the U.S. medium- and heavy-duty market. Additionally, sixteen states and the District of Columbia have signed a Memorandum of Understanding to spur the adoption of medium- and heavy-duty ZEVs.[80]

Useful Life and Warranty Requirements

CARB's useful life and warranty requirements for new on-road heavy-duty vehicles exceeds the stringency of any other in the nation for MY 2022 - 2026. Currently, no other state has more stringent warranty requirements than California. California is the

[76] U.S. EPA, 2023. "Proposed Rule: Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles – Phase 3" https://www.epa.gov/regulations-emissions-vehicles-and-engines/proposed-rule-greenhouse-gas-emissions-standards-heavy

[77] U.S. EPA, 2023. "California Waiver Requests for Heavy-Duty Vehicle Emission Regulations" https://www.epa.gov/regulations-emissions-vehicles-and-engines/california-waiver-requests-heavy-duty-vehicle-emission

[78] U.S. EPA, 2022. "Heavy-Duty 2027 and Beyond: Clean Trucks Final Rulemaking" https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P101695R.pdf

[79] ICCT 2021 https://theicct.org/wp-content/uploads/2022/01/state-level-hdv-emissions-reg-FS-dec21.pdf

[80] Multi-State Medium- and Heavy-Duty Zero Emission Vehicle Memorandum of Understanding, 2020 https://ww2.arb.ca.gov/sites/default/files/2020-07/Multistate-Truck-ZEV-Governors-MOU-20200714.pdf signatories include CA, CO, CT, DC, HI, ME, MD, MA, NJ, NY, NC, OR, PA, RI, VT, and WA. Virginia also signed in December 2021 https://www.sierraclub.org/press-releases/2021/12/governor-northam-signs-virginia-multi-state-agreement-electrify-trucks-and

only state with the authority to initially adopt and enforce emission standards and test procedures for new motor vehicles and new motor vehicle engines that are more stringent than federal emission standards and test procedures. For MY 2022 – 2026, CARB's warranty requirements are more stringent than federal standards, and California's useful life requirements align with federal requirements. Under the Omnibus Regulation, California warranty and useful life requirements are at least as stringent as federal requirements for My 2027 – 2031 and later model years.

Lower In-Use Emission Performance Standards and Test Procedures

CARB's in-use emission performance standards and test procedures for new on-road heavy-duty engines and vehicles exceeds the stringency of any other state in the nation. California is the only state with emission performance standards and test procedures for new on-road heavy-duty engines and vehicles that exceed the stringency of U.S. EPA requirements.

OBD Requirements

CARB and federal OBD regulations for heavy-duty vehicles generally align for MY2013 and newer engines, although CARB's program has been amended to be more stringent than U.S. EPA's for certain vehicle types. California OBD requirements are overall at least as stringent as applicable federal requirements, and California OBD fault detection requirements are at least as stringent if not more stringent than U.S. EPA requirements. However, in 2022, U.S. EPA updated their OBD requirements applicable to 2027 and subsequent model years to delete some California requirements and add some emission control system data parameters to be provided on demand and in the driver display. No other state has more stringent OBD requirements than California.

IN-USE EMISSION CONTROLS FOR HEAVY-DUTY VEHICLES

In-Use Inspection Program

The Inspection / Maintenance (I/M) Program testing and in-use emission controls in the South Coast for on-road heavy-duty trucks and buses are consistent with the most stringent of any other I/M program in the nation.

Opacity Limits

New Jersey has opacity limits that range from 40 percent to 20 percent.[81] Under the ***2018 Amendments to the Periodic Smoke Inspection Program,*** California opacity limits are the most stringent in the nation, ranging from 40 percent to 5 percent.

I/M Testing

CARB's HDVIP program requires heavy-duty trucks and buses to be inspected for excessive smoke and tampering, and engine certification label compliance, including all applicable OBD requirements. Any heavy-duty vehicle traveling in California, including vehicles registered in other states and foreign countries, may be tested. Tests are performed by CARB inspection teams at border crossings, weigh stations, fleet facilities, and randomly selected roadside locations. Owners of trucks and buses found in

[81] For more information on the New Jersey Opacity Limits, please see http://www.nj.gov/dep/bmvim/bmvim_emisStds.htm

violation are subject to minimum penalties starting at $300 per violation. The PSIP program requires that diesel and bus fleet owners conduct annual smoke opacity inspections of their vehicles and repair those with excessive smoke emissions to ensure compliance. CARB randomly audits fleets, maintenance and inspection records and tests a representative sample of vehicles. All vehicles that do not pass the test must be repaired and retested. A fleet owner that neglects to perform the annual smoke opacity inspection on applicable vehicles is subject to a penalty of $500 per vehicle, per year.

Comparatively, three other states have efforts to include OBD testing on heavy-duty vehicles, which are summarized below:

- Massachusetts currently requires opacity testing for diesel engines over 14,000 lbs., GVWR, and OBD testing starting at 2007, with plans to develop a more stringent OBD testing program that will include OBD testing on vehicles 14,000 lbs., GVWR and above;
- New Jersey currently requires opacity testing for diesel engines over 18,000 lbs., GVWR, and has announced the award of a new program to include OBD testing on all diesels over 18,000 lbs., GVWR; and
- Wisconsin currently requires OBD testing for diesel engines up to 14,000 lbs., GVWR, which began in 2007. Wisconsin is considering an option to move toward testing OBD on 14,000 lbs., GVWR and above in the future.

While Massachusetts and New Jersey are developing similar I/M programs as California (all three states are collecting OBD test data for vehicles over 14,000 lbs., GVWR) no jurisdictions aside from California are currently enforcing on OBD scans for vehicles over 14,000 lb. GVWR. Furthermore, none include the potential use of telematics or are trying to also capture out-of-State trucks in the program as California's control program does. Thus, CARB's I/M testing controls program (including the HD I/M, HDVIP and PSIP regulations) are the most stringent in the nation, with further increases in stringency going into effect in 2024.

Idling Requirements

The idling requirements in the South Coast's plan are aligned with the most stringent in the nation. California has a 5-minute idling time restriction. In addition, it has emission performance requirements for alternative idle reduction technologies such as auxiliary power units (APU) and fuel-fired heaters. While other states have adopted similar HD idling requirements as California, none have surpassed the stringency of California requirements in effect, due to the unique exemptions provided California under the Act that enables CARB to set emissions performance requirements that exceed the stringency of those required by U.S. EPA. The following states, counties and cities have more stringent timing requirements for idling time restrictions. However, they do not set performance requirements for idle reduction technologies to reduce the intensity of emissions emitted over a given amount of time.

- The City of Philadelphia (PA) has the most stringent idling restriction of 2-minutes with no exemptions.

- Salt Lake City and Salt Lake County in Utah have also idling restrictions of 2 minutes with some exemptions but still more stringent than California idling restrictions.
- Connecticut, the District of Columbia, City of Ketchum (Idaho), New York City (NY), the Village of Larchmont (NY), the Village of Mamaroneck (NY), the County of Westchester (NY), Park City (Utah), and the City of Birmingham (Vermont) have idling time restriction of 3 minutes with some exemptions.
- Delaware, Chicago (Illinois), New Jersey, Town of Mamaroneck (NY), and Rockland County (NY) also have 3-minute idling restrictions, but their exemptions make their rules less stringent than California idling rule.

Only California has emission performance requirements for idle reduction technologies. Therefore, even if another jurisdiction has an idle time restriction shorter than California's 5-minute idling restriction, for sleeper cabs that use APUs as an alternative technology, California's regulation is more stringent because of the differences in APU emissions. Thus, all other state, county, or city idling rules are less stringent than California's idling restriction.

Heavy-Duty Fleet Rules

California's fleet rules for heavy-duty trucks and buses are the most stringent of any in the nation. The Truck and Bus Regulation requires that by 2014, nearly all vehicles operating in California will have PM emission controls, and by 2023 nearly all vehicles will meet 2010 model year engine emissions levels. The Regulation applies to nearly all diesel fueled trucks and buses with a gross vehicle weight rating greater than 14,000 pounds that are privately or federally owned, including on-road and off-road agricultural yard goats, and privately and publicly owned school buses. Moreover, the Regulation applies to any person, business, school district, or federal government agency that owns, operates, leases or rents affected vehicles. No other state requires diesel particulate filters and MY 2010 + equivalent engines as a mandatory fleet rule affecting nearly the entire on-road diesel fleet.

Approved by CARB in April 2023, the Advanced Clean Fleets Regulation is a nation-leading zero-emission fleet requirement. The Advanced Clean Fleets Regulation accelerates ZEV adoption in the medium-to heavy-duty sectors and for light-duty package delivery trucks by setting zero-emission requirements for fleets. This Regulation targets drayage trucks, public fleets, and other high priority fleets with 50 or more trucks or entities with trucks and $50 million in annual revenues. This effort is part of a comprehensive strategy to achieve a ZEV truck and bus fleet by 2045 everywhere feasible, and significantly earlier for certain well-suited market segments such as last mile delivery, drayage, and government fleets. No other state has zero-emission requirements for heavy-duty vehicle fleets.

Additionally, California has adopted and implemented fleet-specific rules that are consistent with the most stringent in the nation.

Drayage Trucks

California's in-use emissions controls for drayage trucks are the most stringent in the nation. The Truck and Bus Regulation requires 2010 Model Year or newer engines at ports and rail yards starting in 2023. Under the recently approved Advanced Clean Fleets Regulation, CARB is further strengthening emission controls for drayage fleets; all drayage trucks entering seaports and intermodal railyards would be required to be zero-emission by 2035. No other jurisdiction mandates more stringent fleet requirements for drayage trucks.

Solid Waste Collection Vehicles

California's in-use emissions controls for SWCVs are the most stringent in the nation. New York City (NY) is implementing a control measure that began in 2017 to modernize the city's fleet of diesel-powered solid waste vehicles of approximately 2,000 trucks used for picking up residential waste and recyclables with newer, less-polluting models. This program requires that at least 90 percent of the approximately 8,300 qualifying vehicles must meet the tougher emission control standards for diesel trucks that the U.S. EPA set in 2007.[82] Comparatively, California's Solid Waste Collection Vehicle Regulation was adopted in 2003 to reduce toxic diesel PM from approximately 12,000 diesel fueled commercial and residential SWCV and recycling collection vehicles operated in California. The rule applies to all SWCVs of 14,000 pounds or more that run on diesel fuel, have engines in MYs from 1960 through 2006, and collect waste for a fee.

Compared to New York City's program, CARB's Solid Waste Collection Vehicles Regulation limits PM emissions at approximately the same level of stringency. However, SWCVs with 2007-2009 engines were also subject to more stringent 2010 engine requirements under Truck and Bus (which requires diesel particulate filters and MY 2010 + equivalent engines), meaning that the overall level of emission controls are more stringent in California than any other jurisdiction. Additionally, the Advanced Clean Fleets Regulation accelerates ZEV adoption among solid waste collection vehicles. The Regulation will phase in ZEV requirements for different fleets, including waste fleets. Starting in 2036, 100 percent of solid waste collection vehicle sales in California would be zero-emissions. No other state has zero-emission requirements for SWCVs.

Public Fleet Rules

California's in-use emissions controls for public fleets are the most stringent in the nation. The city of Boston (MA) requires that, all pre-2007 City-owned or operated vehicles to have equipment that reduces diesel emissions by at least 20 percent by the end of 2015, and that all pre-2007 diesel vehicles and equipment not previously retrofit would be required to have retrofits achieving at least 85-percent—or best available—pollution reductions by the end of 2018. Public fleets in California are subject to the Truck and Bus Regulation, which requires diesel particulate filters and MY 2010+ equivalent engines. California's statewide Public Agency and Utility Regulation requires any municipality or utility that owns, leases, or operates on-road diesel fueled vehicles with engine model year 1960 or newer and GVWR greater than 14,000 pounds to

[82] https://www.nytimes.com/2016/08/19/opinion/how-garbage-trucks-can-drive-a-green-future.html

reduce PM2.5 emissions to 0.01 g/bhp-hr. This can be done by repowering, retrofitting, or retiring the vehicle. Implementation of the rule started in 2007, with a compliance schedule based on the engine model year. Comparatively, CARB's Public Agency and Utility Regulation requires similar stringency in PM emissions limits as the Boston, MA program; because some utility fleets are also subject to more stringent requirements under the Truck and Bus Regulation, the overall level of emission controls are more stringent in California than any other jurisdiction.

Additionally, the Advanced Clean Fleets Regulation will phase in ZEV requirements for public fleets in California. State and local government fleets – including cities, counties, special districts, and other municipalities – would be required to add only ZEVs to their fleets starting at 50 percent of new purchases in 2024 and 100 percent starting in 2027, or fleets may opt to phase-in ZEV requirement where a portion of the fleet must be zero-emission based on a pre-determined schedule. Small public fleets and those that are based in designated low population counties would begin with 100 percent ZEV additions starting in 2027.

Transit Fleets

California's in-use emission controls for transit vehicles are the most stringent in the country. CARB's Transit Fleet Rule requires emission reductions (PM and NOx) from urban buses and transit fleet vehicles and required future zero-emission bus purchases. Additionally, the Innovative Clean Transit Regulation requires all public transit agencies to gradually transition to a 100 percent ZEB fleet. Beginning in 2029, 100 percent of new purchases by transit agencies must be ZEBs, with a goal for full transition by 2036. No other jurisdiction mandates more stringent fleet requirements for transit fleets.

Last Mile Delivery Trucks

California's in-use emission controls for last mile delivery vehicles (Class 3-7 heavy-duty delivery trucks used to deliver freight from warehouses and distribution centers to the final point of sale or use) are the most stringent in the nation. Truck and Bus requires MY 2010 or equivalent engines by 2023. Additionally, the Advanced Clean Fleets Regulation accelerates ZEV adoption in the medium- to heavy-duty sectors and for light-duty package delivery trucks by setting zero-emission requirements for high priority fleets with 50 or more trucks or entities with trucks and $50 million in annual revenues. The regulation will phase in ZEV requirements for different fleets, resulting in 100 percent of medium- and heavy-duty vehicle sales in California being zero-emissions starting in 2036. No other jurisdiction mandates more stringent fleet requirements for last mile delivery trucks.

Airport Shuttle Buses

California's emission controls for airport shuttle buses (vehicles used to transport passengers between car parking lots, airport terminals, and airport car rental facilities) are the most stringent in the nation. The Truck and Bus Regulation requires MY 2010 or equivalent engines by 2023. Additionally, the Zero-Emission Airport Shuttle Bus Regulation requires airport shuttle operators to transition to 100 percent ZEV technologies. Airport shuttle operators must begin adding zero-emission shuttles to their fleets in 2027, and complete the transition to ZEVs by the end of 2035. The Regulation applies to airport shuttle operators who own, operate, or lease vehicles at any of the 13

California airports regulated under this rule (regulated airports), including the Fresno Yosemite International Airport. No other jurisdiction mandates more stringent fleet requirements for airport shuttle buses.

School Buses

Colorado controls emissions from school buses through a School Bus Retrofit Program funded by DERA Grants from U.S. EPA. This program began in 2009, and reduces emissions of diesel exhaust by retrofitting school buses with proven emissions-reduction technologies, including diesel-oxidation catalysts, engine preheaters and closed-crankcase filtration systems. Comparatively, California's Truck and Bus regulation requires that all privately and publicly owned school buses are equipped with diesel PM filters. California also limits bus and vehicle idling time near schools or at school bus destinations through the School Bus ATCM. It has been in effect since 2003 and reduces emissions from more than 26,000 school buses that operate daily at or near schools. The School Bus ATCM targets school buses, school pupil activity buses, youth buses, paratransit vehicles, transit buses, and heavy-duty commercial motor vehicles that operate at or near schools.

Additionally, CARB's School Bus Incentive Program has invested over $1.2 billion to date to clean up old, higher-polluting school buses. The California Legislature recently appropriated an additional $1.8 billion for zero-emission school buses and associated charging infrastructure over the next five years. Over the last twenty years, the total $1.2 billion statewide investment made, including $255 million invested in school bus cleanup over the past year alone, has supported about 1,800 zero-emission school buses. More than 560 of those buses are already on California roadways, with 327 in the State's most pollution-burdened communities.[83]

New York State's enacted fiscal year 2022-2023 budget established a requirement for all new school buses purchased to be zero emission by 2027.[84] Under the New York law, all school buses must be electric, including district-owned and leased vehicles upon full implementation in 2035.[85] New York is the only state the nation with an in zero-emission school bus requirements. California, however, leads the nation with its deployment of about 1,800 zero-emission school buses. By comparison, 888 zero-emission school buses have been awarded, ordered, or deployed across the U.S. outside of California, as of 2021.[86] While CARB incentive programs have turned over the most school buses to zero-emission engines of any state to date, California does not currently have any proposed or current regulations that require electrification of the school bus fleet.

CARB utilizes incentive programs rather than mandating turnover through regulatory actions due to the costs of zero-emission school buses, and particularly due to the impact those costs would have on public school districts. Public school districts often do not have the funding to replace their aging school bus fleet. Based on a comprehensive

[83] CARB, 2022 https://ww2.arb.ca.gov/news/new-report-shows-how-california-leading-nation-cleaning-school-buses
[84] New York Senate Bill S8006C https://www.nysenate.gov/legislation/bills/2021/S8006
[85] Rockefeller Institute of Government, November 2022 https://rockinst.org/blog/meeting-new-yorks-electric-school-bus-mandate-takeaways-from-the-2022-school-finance-symposium/
[86] CARB, 2022 https://ww2.arb.ca.gov/news/new-report-shows-how-california-leading-nation-cleaning-school-buses

assessment of funding for home-to-school transportation conducted by the Legislative Analyst's Office in 2014,[87] the primary responsibility for school transportation funding lies with public school districts through the State legislative process. Investing in California's school bus fleet is a collective effort amongst agencies on the local, state, and federal level. CARB and CEC have led the effort in dedicating funding and resources to turning over old, dirty school buses and investing in new technologies.[88] Together, CARB and CEC have made significant progress to make it easier for school districts to access zero-emission school bus and charging/fueling infrastructure incentives in a coordinated, streamlined manner. If CARB were to adopt a regulatory program that mandated zero-emission school buses, the ability to use incentive funds to help alleviate school districts of the burden of purchasing these new buses would be compromised, due to requirements in most of CARB's incentive funding programs that require that incentive dollars are spent on turning over vehicles and mobile equipment that exceed regulatory requirements.

FUELS

Diesel Fuel Regulations

U.S. EPA began regulating sulfur content in diesel in 1993. At that time, uncontrolled fuels (i.e. non-CARB diesel) contained approximately 5,000 parts per million (ppm) of sulfur. In 2006, U.S. EPA began to phase-in more stringent requirements under the federal Ultra-Low Sulfur Diesel (ULSD) regulations, which lowered the amount of sulfur in on-road diesel fuel to 15 ppm. The On-road (Highway) Diesel Fuel Standard was phased-in from 2006 to 2010, and since 2011 have required that all highway diesel fuel supplied to the market be ULSD, and that all highway diesel vehicles must use ULSD.

CARB's Ultra-Low Sulfur Diesel (ULSD) program limits sulfur content at the same levels as U.S. EPA's on-road ULSD program (i.e. at 15 ppm); however, due to other specifications that uniquely apply to CARB diesel, the California program reduces emissions significantly relative to federal diesel, providing about a 7 percent reduction in NOx and 25 percent in diesel PM.[89] Furthermore, CARB is anticipated to further increase the stringency of controls on criteria pollutant emissions diesel products under ***the Low Emission Diesel measure***. No other state or nonattainment area controls criteria emissions from renewable fuels more stringently than CARB.
Beyond the federal diesel requirements described above, the Act also allows states to adopt unique fuel programs to meet local air quality needs, which are referred to as Boutique Fuel Programs. As of January 19, 2017, U.S. EPA identified only one boutique fuel programs that had been approved in a SIP,[90] the Low Emission Diesel Program in Texas (TxLED). The fuel specifications for the TxLED are based on CARB diesel

[87] Legislative Analyst's Office, 2014. "Review of School Transportation in California" https://lao.ca.gov/reports/2014/education/school-transportation/school-transportation-022514.pdf
[88] CARB https://ww2.arb.ca.gov/sites/default/files/2022-10/fy2022_23_funding_plan_appendix_e.pdf
[89] Beyond sulfur limits at 15 ppm, CARB's program also requires the aromatic hydrocarbon content of the diesel fuel sold in the state not to exceed 10 percent by volume. Alternative diesel fuel formulations can be used to demonstrate equivalent compliance without actually meeting the aromatic limit.
[90] U.S. EPA, 2017 https://19january2017snapshot.epa.gov/gasoline-standards/state-fuels_.html

requirements,[91] and fuel formulations approved by CARB are also considered approved by the Texas Commission on Environmental Quality, and may be used to comply with the TxLED regulations.[92] Additionally, independent analysis of TxLED, CARB ULSD and federal ULSD shows that the TxLED fuel emissions performance does not provide as significant of emission reduction benefits as the California specifications,[93] although U.S. EPA credited the TxLED program with providing approximately a 5 percent NOx emission reduction benefit over federal ULSD fuels.[94] Furthermore, the stringency of Texas' testing requirements are based on the federal Complex Model, which is less stringent and nuanced than the California Predictive Model that is used to determine compliance with California fuel requirements.

Controlling Criteria Emissions from Renewable Fuels

The Low Carbon Fuel Standard (LCFS) and Alternative Diesel Fuel (ADF) regulations work together to limit criteria emissions from alternative fuels. Oregon and Washington State also have low carbon fuel standard programs modeled after the California regulation, California participates in the Pacific Coast Collaborative with these states, in addition to British Columbia. Seven other states are also considering a clean fuel regulation, including New York, Michigan, Minnesota, New Mexico, Vermont, Illinois, and Massachusetts.

While other states have adopted or are considering adopting similar programs to the California LCFS, no other state has set criteria emission requirements on alternative fuels. U.S. EPA's Renewable Fuel Standard (RFS II) does not specify criteria emission requirements for alternative fuels.

[91] Texas Administrative Code Title 30 Part I Chapter 114 Subchapter H, Division 2 Rule §114.312 http://texreg.sos.state.tx.us/public/readtac%24ext.TacPage?sl=R&app=9&p_dir=&p_rloc=&p_tloc=&p_ploc=&pg=1&p_tac=&ti=30&pt=1&ch=114&rl=312

[92] Texas Commission on Environmental Quality https://www.tceq.texas.gov/assets/public/implementation/air/sip/texled/List%20of%20TCEQ-Approved%20Alternative%20Diesel%20Formulations.pdf

[93] American Transportation Research Institute (ATRI) 2008 "Energy and Other Fuel Property Changes with On-Road Ultra-Low Sulfur Diesel Fuel" http://www.atri-online.org/research/results/environmentalfactors/2008ATRIDiesel.pdf

[94] U.S. EPA 2001, "Approval and Promulgation of Air Quality State Implementation Plans (SIP); Texas: Low Emission Diesel Fuel" https://www.federalregister.gov/documents/2001/11/14/01-27581/approval-and-promulgation-of-air-quality-state-implementation-plans-sip-texas-low-emission-diesel Federal Register Vol. 66, No. 220 pages 57196-57219

STEP 3(A): EVALUATION OF STRINGENCY: MEDIUM- AND HEAVY-DUTY CONTROL MEASURES

Step 3(a) calls for an evaluation of each of the potential control measures identified in Step 2, in order to evaluate their stringency and determine whether they meet all applicable requirements to satisfy the definitions of MSM as discussed in Section 1 and Section 2.

As shown in the Table 17 in Step 2(b), CARB's programs are the most stringent in the nation. This comparison between CARB's control measures and the measures currently in place at the federal level and/or within other states and jurisdictions illustrates the stringency of the CARB on-road heavy-duty control program, which meets the stringency requirements of MSM.

Furthermore, CARB staff have conducted an analysis of the timing of the new measures included in the 2022 State SIP Strategy, which go beyond the stringency of the current control program as it is now being implemented. Many of these measures are still in their development phases and are not yet being implemented; the development timeline, however, is critical to allowing industry and technological advancements to progress sufficiently such that the newly emerging technologies called for in these regulatory actions (most of which are technology-inducing regulations) have sufficient time to attain market readiness. Table 18, below, discusses the timeframe considerations for each of the applicable medium- and heavy-duty control measures, and indicates why a more expedited timeframe is neither technologically nor economically feasible. For these reasons, the measures meet the MSM requirement of being phased in as "expeditiously as practicable".

Table 18: Medium- and Heavy-Duty Control Measures – Stringency and Timeline for Implementation

Measures	Implementation Begins	12 µg/m^3 Annual PM2.5 Standard (2012)
New Heavy-Duty Vehicle Standards		
Mandatory Emission Standards (Internal Combustion Engines)		
Heavy-Duty Emission Standards for New Vehicles and Engines (Mandatory)	ongoing	MSM
Heavy-Duty Omnibus Regulation (Mandatory Emission Standards)	2024	MSM
CARB's mandatory emission standards for heavy-duty vehicles and engines harmonize with federal standards for NOx and PM emission requirements though MY 2023. For MY 2024 and later, the Omnibus regulation established new low NOx and lower PM Standards that, when implemented, will be the lowest in the nation. Adopted in 2021, the omnibus regulation is a technology-forcing regulation; further stringency is infeasible. The Omnibus regulation also lengthened the useful life and emissions warranty provisions for heavy-duty diesel engines. Heavy-Duty emission standards for new vehicles and engines require years of lead time to be developed, certified, manufactured, and implemented; a more accelerated timeline is infeasible.		
Optional Emission Standards (Internal Combustion Engines)		
Optional Low-NOx Emission Standards for Heavy-Duty Engines	ongoing	MSM
Heavy-Duty Omnibus Regulation (Optional Emission Standards)	2024	MSM
CARB's optional Low-NOx emission standards are the most stringent in the nation, and are technology-forcing regulations that have driven the development and market readiness of the cleanest heavy-duty engines. The Omnibus regulation, when implemented, will further lower CARB's optional low-NOx emission standards to an even lower level; further increases in stringency are not feasible. Vehicle emission standards, including optional standards, are dependent on technological development, and require years of lead time to be developed, certified, manufactured, and implemented; a more accelerated timeline is infeasible.		
Zero-Emission Truck Standards – Sales and Manufacturer Requirements		
Advanced Clean Trucks	2024	MSM
Adopted in 2020, the Advanced Clean Trucks (ACT) regulation established manufacturer zero-emission truck sales requirements for Class 2b – Class 8 trucks beginning in 2024, as well as company and fleet reporting requirements. The ACT regulation has the most stringent zero-emission truck requirements in the nation. As a technology-forcing regulation, ACT will accelerate the development and deployment of Zero-Emission Heavy-Duty trucks and engines; further increases in stringency are not feasible. Manufacturer sales requirements need years of lead time to be implemented; it would be infeasible to implement on a more accelerated timeframe.		
Warranty, Useful Life, and On-Board Diagnostics (OBD) Requirements		
California Emission Control System Warranty and Maintenance Provisions	ongoing	MSM
Amendments to Useful Life & Warranty Provisions (as part of Omnibus)	2027	MSM
For MY 2022 - 2026 engines, California's Emission Control System Warranty and Maintenance Provisions are the most stringent in the nation. Adopted in 2021, the Omnibus Regulation further amended the warranty and useful life provisions for heavy-duty engines for MY 2027 and later years. To help ensure emission controls are well maintained and repaired when needed, and to help ensure more durable emission control systems, Omnibus extends the criteria pollutant emissions warranty and useful life period requirements for heavy-duty vehicles and engines. For My 2027 – 2031 and later years, California warranty and useful life requirements are at least as stringent as the federal requirements. As technology-forcing regulations, California's warranty and maintenance provisions are the most stringent in the nation; further increases in stringency are not feasible. Likewise, an accelerated timeline is not feasible; the requisite technological innovations and developments needed to meet California's level of stringency require years of lead time for implementation, as manufacturers must have sufficient time to develop, test, certify, and manufacture these needed advanced technologies.		
Heavy-Duty On-Board Diagnostics (HD OBD) and OBD II	ongoing	MSM
Amendments to Useful Life & Warranty Provisions (as part of Omnibus)	2024	MSM
The Heavy-Duty OBD regulation required that all MY 2013 and later engines offered for sale in California come equipped with OBD systems. CARB and federal OBD regulations for heavy-duty vehicles generally align for MY2013 – current engines, although CARB's program has been amended to be more stringent than U.S. EPA's for certain vehicle types. With the 2021 adoption of the Omnibus regulation, California's threshold for OBD requirements will become more stringent, concurrent with the phase-in of more stringent emission requirements. Omnibus also requires		

Measures	Implementation Begins	12 µg/m^3 Annual PM2.5 Standard (2012)
updates to address cold start emissions and diesel PM monitoring. Many of the regulatory changes are phased-in, as full implementation is not anticipated to be technologically feasible until 2027. As the most stringent requirements in the nation, for these technology-forcing regulations, further increases in stringency are not feasible. Furthermore, because OBD requirements need significant lead time to be developed, adopted, and implemented, they require sufficient lead time for manufacturers to develop, test, and manufacture the needed hardware and/or software changes, and to verify via testing; an accelerated timeline for implementation is therefore not feasible.		
In-Use Emission Control Measures		
Inspection and Maintenance Provisions		
HD Diesel Vehicle Inspection Program (HDVIP)	ongoing	MSM
Periodic Smoke Inspection Program (PSIP)	ongoing	MSM
HD Inspection and Maintenance Program (HD I/M)	ongoing	MSM
Heavy-Duty In-Use Testing Program (HDIUT) (Part of Omnibus Regulation)	2024	MSM
California's in-use testing program (including the HD I/M, HDVIP and PSIP regulations) is the most stringent in the nation, with further increases in stringency going into effect in 2024 (HDIUT). • Amended in 2018, HDVIP requires heavy duty vehicles to be inspected for smoke opacity, tampering, and engine certification label compliance. PSIP identifies malfunctioning PM emission control components and requires their repair. The 2018 amendments to HDVIP and PSIP lowered the smoke opacity limits and required engines over four years old to be inspected annually. • Adopted in 2021, HD I/M is a comprehensive heavy-duty vehicle inspection and maintenance regulation requiring periodic vehicle emissions testing and reporting on nearly all heavy-duty vehicles operating in California. Combining periodic vehicle testing with other emissions monitoring and expanded enforcement strategies, the HD I/M regulation ensures that vehicles' emissions control systems are properly functioning when traveling on California's roadways, and that polluting, poorly maintained heavy-duty vehicles operating in California are quickly identified and repaired. As of 2023, CARB is using roadside emissions monitoring devices (REMD) to screen for vehicles that may have high emissions. • To ensure that in-use heavy-duty vehicles continue to operate at their cleanest possible level, the 2020 Omnibus regulation amended the Heavy-Duty In-Use Testing (HDIUT) Program by revising procedures to better represent heavy-duty vehicle operations in real world conditions, establishing clearer criteria for engine family pass/fail determination, and requiring on-board diagnostic (OBD) data during testing to verify the condition of the test vehicle and sensors. California's HD inspection and maintenance requirements are the most stringent in the nation; further increases in stringency are not feasible. Further increases in stringency under the Omnibus Regulation take effect next year and are phased-in in subsequent years to allow regulated parties and manufacturers sufficient lead time to comply with the regulation's stringency; a more accelerated timeline is infeasible.		
Diesel Idling Requirements		
HD Idling Reduction Program	ongoing	MSM
Reduced Idling Limits (as part of Omnibus)	2024	MSM
School Bus Idling ATCM	ongoing	MSM
The HD Idling Reduction Program requires that drivers of diesel-fueled commercial motor vehicles (GVWR < 10,000 lbs), including buses and sleeper berth equipped trucks, not idle the vehicle's primary diesel engine longer than five minutes at any location. The regulation also consists of new engine and in-use truck requirements and emission performance requirements for technologies used as alternatives to idling the truck's main engine. Under the new engine requirements, 2008 and newer model year heavy-duty diesel engines need to be equipped with a non-programmable engine shutdown system that automatically shuts down the engine after five minutes of idling. The Omnibus regulation further reduces diesel idling limits from 30 g/hr to 10 g/hr in MY 2024, and to 5 g/hr in MY 2027+ engines. In addition to the idling limits required under the HD Idling Reduction program and the Reduced Idling Limits as part of the Omnibus Regulation, the School Bus Idling Airborne Toxic Control Measure (School Bus ATCM) further limits bus and commercial motor vehicle idling near schools or at school bus destinations to only when necessary for safety or operational concerns. California's idling requirements are the most stringent in the nation; further increases in stringency are not feasible. Reduced idling limits from the Omnibus Regulation take effect next year (2024+) and are phased-in in subsequent years to allow regulated parties and manufacturers sufficient lead time to comply with the regulation's stringency; a more accelerated timeline is infeasible.		
Fleet Rules - General		
Truck and Bus	ongoing	MSM

Measures	Implementation Begins	12 µg/m^3 Annual PM2.5 Standard (2012)
Advanced Clean Fleets (ACF) Regulation (2022 State SIP Strategy measure, adopted April 2023)	2024	MSM
Zero-Emission Trucks Measure (2022 State SIP Strategy measure with commitment)	2030	MSM
California's heavy-duty fleet rules are the most stringent in the nation, and have continually relied on the newest developments in advanced clean technologies that are spurred by CARB's new engine and vehicle standards. For the timeline of analysis for this document, there have been / will be three generations of fleet rules, which transition California's heavy-duty fleet from low-emission internal combustion engines to increasingly stringent requirements for zero-emission technologies: • Adopted in 2010, the Truck and Bus regulation requires heavy-duty diesel vehicles that operate in California to reduce exhaust emissions. By 2023, nearly all trucks and buses will be required to have 2010 or newer model year engines to reduce PM and NOx. • Building on the successful emission reductions from Truck and Bus, the Advanced Clean Fleets (ACF) regulation would transition CARB's fleet rules toward establishing zero-emission purchasing requirements for medium- and heavy-duty vehicle fleets (including state and local agencies, and drayage fleets, high priority, and federal fleets), beginning in 2024. ACF would also require 100% zero-emission new vehicle sales starting 2040. Under the recently-adopted ACF regulation, together with the ACT regulation, the number of medium- and heavy-duty ZEVs operating in California will be about 1.2 7 million by 2045. • The future Zero-Emission Trucks Measure would build on the rollout of ZE trucks through the Advanced Clean Trucks and Advanced Clean Fleets regulations by going beyond ACF requirements and further increasing the number of ZEVs, with the goal of achieving a full ZEV fleet by 2045 everywhere feasible. It would seek to expand the ZEV market in a manner that is economically feasible for more than 100,000 fleets where some cannot afford to purchase new trucks and will not be able to operate without access to retail ZEV infrastructure, especially for long-haul and inter-state vehicles. Fleet requirements need years of lead time to be implemented for reasons of technological and economic feasibility. As purchasing requirements and fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements. California's currently committed to heavy-duty fleet requirements are technology-forcing and are the most stringent in the nation, as they will eventually exclusively require zero-emission trucks and engines; further increases in stringency are not feasible.		
Fleet Rules - Drayage Trucks		
Truck and Bus	ongoing	MSM
Advanced Clean Fleets (ACF) Regulation (2022 State SIP Strategy measure, adopted April 2023)	2024	MSM
Drayage trucks are subject to requirements under the Truck and Bus Regulation, which requires MY 2010 or newer engines on drayage trucks entering ports and rail yards, beginning in on January 1, 2023. Under the Advanced Clean Fleets (ACF) Regulation, CARB will further strengthen emission controls for drayage fleets with zero-emission drayage truck requirements. Drayage trucks will be required to start transitioning to zero-emission technology beginning in 2024, with full implementation by 2035. Fleet requirements need years of lead time to be implemented for reasons of technological and economic feasibility. As purchasing requirements and fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements. California's fleet requirements for drayage trucks are technology-forcing and are the most stringent in the nation, as they will require zero-emission trucks and engines; further increases in stringency are not feasible.		
Fleet Rules - Solid Waste Collection Vehicles (SWCVs)		
Solid Waste Collection Vehicle Regulation	ongoing	MSM
Truck and Bus	ongoing	MSM
Advanced Clean Fleets (ACF) Regulation (2022 State SIP Strategy measure, adopted April 2023)	2024	MSM
Adopted in 2003, the Solid Waste Collection Vehicle Regulations reduce diesel PM from SWCVs by requiring engines equivalent to the 2007 MY standard of 0.01 g/bhp-hr. SWCVs are also subject to requirements under the Truck and Bus Regulation, which requires MY 2010 or newer engines as of January 1, 2023. The ACF regulation will accelerate ZEV adoption among SWCVs, with a goal of 100 percent ZE vehicle sales in California starting in 2036. Fleet requirements need years of lead time to be implemented for reasons of technological and economic feasibility. As purchasing requirements and fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements. California's fleet requirements for SWCVs are technology-forcing and are the most stringent in the nation, as they will require zero-emission trucks and engines; further increases in stringency are not feasible.		

CARB Control Program MSM Analysis for the SCAQMD 2024 12 µg/m^3 annual PM2.5 Plan

Measures	Implementation Begins	12 µg/m^3 Annual PM2.5 Standard (2012)
Fleet Rules - Public Agencies and Utilities		
Public Agency and Utility Regulation	ongoing	MSM
Truck and Bus	ongoing	MSM
Advanced Clean Fleets (ACF) Regulation (2022 State SIP Strategy measure, adopted April 2023)	2024	MSM
The Public Agency and Utility Regulation requires PM emission limits comparable to the 2007 MY standard of 0.01 g/bhp-hr for engine MY 1960 or newer. Some public and utility fleets are also subject to requirements of Truck and Bus, and must have MY 2010 or newer engines as of January 1, 2023. The ADF regulation accelerates ZEV adoption among all state and local government and utility fleets, starting with a 50% purchase requirement in 2024, with increasingly stringent requirements phased-in over subsequent years. Fleet requirements need years of lead time to be implemented for reasons of technological and economic feasibility. As purchasing requirements and fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements. California's fleet requirements for public and utility fleets are technology-forcing and are the most stringent in the nation, as they will require zero-emission trucks and engines; further increases in stringency are not feasible.		
Fleet Rules - Transit Agencies		
Fleet Rule for Transit Agencies	ongoing	MSM
Innovative Clean Transit	2023	MSM
The Transit Fleet Rule requires PM and NOx emission reductions from urban buses and transit fleet vehicles, and required future zero-emission bus purchases. Adopted in 2018, the Innovative Clean Transit (ICT) Regulation requires all public transit agencies to gradually transition to a 100 percent zero-emission bus (ZEB) fleet. Beginning in 2029, 100% of new purchases by transit agencies must be ZEBs, with a goal for full transition by 2040. Fleet requirements need years of lead time to be implemented for reasons of technological and economic feasibility. As purchasing requirements and fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements. California's fleet requirements for transit agencies are technology-forcing and are the most stringent in the nation, as they will require zero-emission trucks and engines; further increases in stringency are not feasible.		
Fleet Rules - Airport Shuttle Buses		
Truck and Bus	ongoing	MSM
Zero-Emission Airport Shuttle Buses	2027	MSM
The Truck and Bus Regulation requires airport shuttle buses to use MY 2010 or equivalent engines by 2023. The Zero-Emission Airport Shuttle Bus Regulation requires airport shuttle operators to transition to 100 percent zero-emission vehicle (ZEV) technologies. Airport shuttle operators must begin adding zero-emission shuttles to their fleets in 2027, and complete the transition to ZEVs by the end of 2035. Fleet requirements need years of lead time to be implemented for reasons of technological and economic feasibility. As purchasing requirements and fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements. California's fleet requirements for airport shuttle buses are technology-forcing and are the most stringent in the nation, as they will require zero-emission trucks and engines; further increases in stringency are not feasible.		
School Buses – In-Use Control Programs		
Truck and Bus	ongoing	MSM
School Bus Idling ATCM	ongoing	MSM
Heavy-Duty Omnibus Regulation	2024	MSM
School Bus Incentive Program	ongoing	MSM
The Truck and Bus regulation applies to school buses > 14,000 lbs., GVWR, and requires the use of diesel particulate filters. The School Bus Idling Airborne Toxic Control Measure (School Bus ATCM) further limits bus and commercial motor vehicle idling near schools or at school bus destinations to only when necessary for safety or operational concerns. Under the Omnibus Regulation, idling limits for diesel heavy-duty vehicles will be reduced from 30 g/hr currently to 10 g/hr in MY 2024 and to 5 g/hr in MY 2027. CARB also uses incentive funds as a key component of the strategy to reduce emissions from the school bus fleet. Over the past two decades, CARB's School Bus Incentive Program has invested over $1.2 billion to date to clean up old, higher-polluting school buses, which has supported about 1,800 zero emission school buses. California's requirements for in-use control programs for school buses are among the most stringent in the nation; it would be infeasible to accelerate the implementation schedule, or require further increases in stringency.		

CARB Control Program MSM Analysis for the SCAQMD 2024 12 µg/m^3 annual PM2.5 Plan

Measures	Implementation Begins	12 µg/m^3 Annual PM2.5 Standard (2012)
Fuels Control Measures		
Conventional Diesel Fuel Standards		
CARB Ultra Low Sulfur Diesel (ULSD)	ongoing	MSM
Low-Emission Diesel Requirement (2016 State SIP Strategy measure, not yet adopted)	TBD	MSM
CARB's Ultra Low Sulfur Diesel (ULSD) regulation was last amended 2003 to establish more stringent standards for diesel fuel, lowering the sulfur limit to 15 ppmw. Relative to federal diesel requirements, CARB ULSD reduces NOx and PM emissions significantly. The Low Emission Diesel measure will require diesel fuel providers to steadily decrease criteria pollutant emissions from their fuels, which will reduce NOx and PM tailpipe emissions. CARB fuel regulations reduce emissions from even those vehicles registered out of state and therefore not subject to CARB's other mobile source control measures. CARB's diesel standards and requirements are the most stringent in the nation, and some of the most stringent in the world; it is not feasible to require further stringency of fuel specifications.		
Alternative Fuel Standards		
Low Carbon Fuel Standard (LCFS)	ongoing	MSM
Alternative Diesel Fuel (ADF) Regulation	ongoing	MSM
The LCFS and ADF regulations work together to reduce the carbon intensity of the California fuel supply. The regulations also limit criteria emissions from alternative fuels and/or alternative fuel mix blends. The regulations were amended in 2018 to extend the carbon intensity target of 20 percent to 2030. No other state or federal requirements have set as stringent of criteria emission requirements on alternative fuels and alternative fuel blends than California. The LCFS and ADF are technology-forcing regulations, and are the most stringent in the nation; further stringency would not be feasible. As it takes fuel producers years to develop, certify, and manufacture new alternative fuel types to meet the increasingly stringent requirements of the LCFS and ADF, an accelerated implementation timeframe would not be feasible.		

STEP 3(B): EVALUATION OF FEASIBILITY: MEDIUM- AND HEAVY-DUTY CONTROL MEASURES

Step 3(b) calls for an assessment of the feasibility of implementing any measure that is not included in the proposed South Coast SIP, but which is identified as a potential control measure in Step 2. During the public process for the 2022 State SIP Strategy, CARB staff received public measure suggestions for additional potential heavy-duty measures, as described below. Staff developed the Zero-Emission Trucks measure in response to these public measure suggestions.

- On-Road Heavy-Duty Vehicle Useful Life Regulation
  This suggestion would involve CARB developing a regulation, potentially paired with new incentives or legislative measures, to require on-road heavy-duty vehicles that have reached the end of their useful life as defined in Senate Bill 1,[95] as the earlier of 800,000 vehicles miles traveled or 18 years from the engine model year to retire, replace, retrofit, or repower the on-road heavy-duty vehicle or engine, and upgrade to zero-emission trucks.

  CARB staff has investigated the feasibility and potential benefits of this suggested measure and have included it as one potential option in the ***Zero-Emission Trucks measure*** in the 2022 State SIP Strategy.

- Additional Incentive Programs: Zero-Emission Trucks
  Additional incentive programs are needed to send clear signals to the market and support new scrap and replace regulatory programs, specifically to help ensure that smaller trucking companies have more consistent access to zero-emission truck incentives. This measure would involve CARB working to develop incentive programs which should include consideration of policies other jurisdictions have employed such as supporting local zero-emission zones and/or differentiated registration fees so that dirtier trucks pay more and zero-emission trucks have a consistent source of incentive funding.

  CARB staff has investigated the feasibility and potential benefits of this suggested measure, and have included it as one potential element of the ***Zero-Emission Trucks measure*** in the 2022 State SIP Strategy.

- Indirect Source Rule
  This measure could involve CARB writing a Suggested Control Measure which acts as a model rule to assist the air districts in the rule development process. An indirect source can be any facility, building, structure, or installation, or combination thereof, which attracts or generates mobile source activity that results in emissions – these include warehouses, railyards, ports, airports, and mobile sources attracted to those warehouses, railyards, ports, and airports. Only a few air districts in California have indirect source rules to limit emissions of this nature on a facility basis.

[95] Beall, Chapter 5, Statutes of 2017 https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB1

CARB staff have investigated the feasibility and potential benefits of this suggested measure, and have included an Indirect Source Regulation as one potential element of the Zero-Emission Trucks measure in the 2022 State SIP Strategy. In addition, CARB staff will explore opportunities to expand existing State law to provide partnership opportunities for CARB and air districts to work together to develop, adopt, and implement indirect source rules.

CARB staff do not recommend eliminating any of the potential medium- and heavy-duty control measures identified on the basis of technical or economic infeasibility.

Off-Road Sources

Off-road mobile sources include a wide variety of engines ranging from locomotives, ships, and aircraft, to equipment used in the agricultural, construction, mining, and freight / goods movement industries. This category is composed of off-road compression ignition (diesel) engines and equipment, small spark ignition off-road engines and equipment less than 25 hp (including lawn and garden equipment, and small industrial equipment), off-road large spark ignition (gasoline and liquefied petroleum gas) engines and equipment 25 hp and greater (including industrial equipment, forklifts, and portable generators), airport ground support equipment, and cargo handling equipment used at railyards, warehouses, and the Ports of LA and Long Beach. Similar to the on-road sectors, California has a comprehensive program for reducing emissions from off-road equipment that goes well beyond current requirements in place elsewhere in the nation.

While emission standards for locomotives are set by U.S. EPA, CARB has accelerated reductions from these sources through efforts that have focused on cleaner fuel requirements, and increasing use of cleaner locomotives. CARB staff and the Class I railroads have also been implementing a memorandum of understanding to accelerate the introduction of cleaner locomotives since 2005. The recently adopted In-Use Locomotive Regulation accelerates the adoption of advanced, cleaner technologies for locomotive operations, including zero-emission technologies.

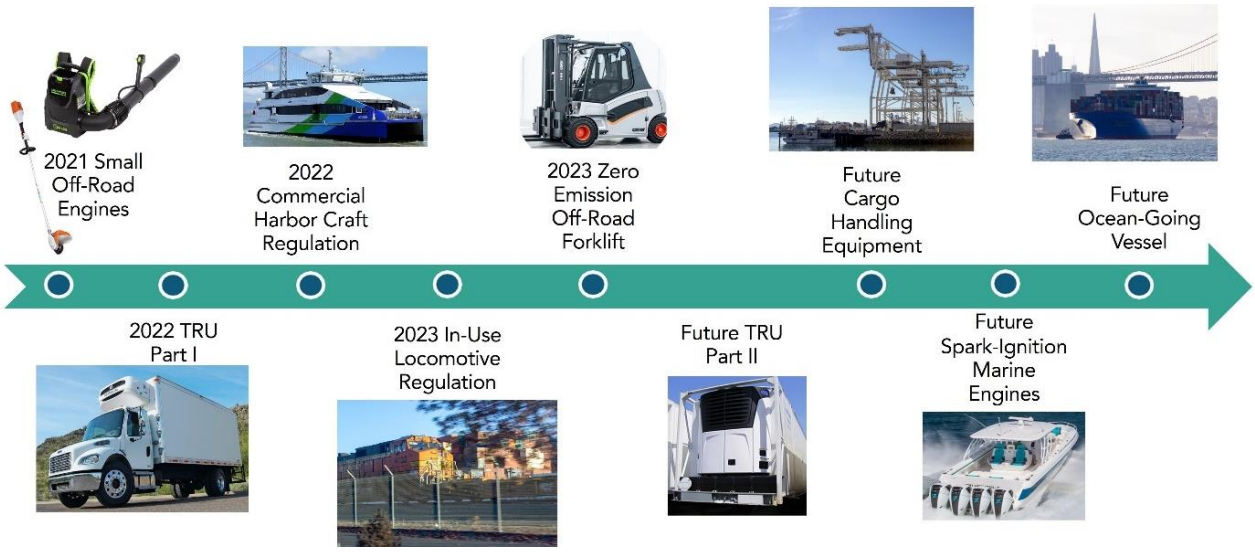
Similarly, emission standards for Ocean-Going Vessels (OGVs) are largely regulated on an international level by the International Maritime Organization (IMO), whose primary focus is reducing NOx and GHG emissions from OGVs. IMO marine engine standards for OGVs regulate NOx emissions only, with no PM standards in place. Increased emissions are occurring from all modes of OGV operations (in transit, maneuvering, anchoring, and at berth) because of increased import/export activity and seaport congestion (which may be associated with a variety of factors, including the global pandemic, increased purchasing by consumers, periodic labor disputes, tariff changes, etc.). The majority of emissions from OGVs occur while vessels are in transit and operating their large slow-speed marine engines, which are typically powered by heavy fuel oil (or “bunker fuel”).96 CARB’s Vessel Clean Fuel Regulation requires OGVs to use 0.1 percent sulfur distillate grade fuels (marine diesel oil/marine gas oil) for all OGVs sailing within 10 nautical miles of the California coast to help reduce emissions from OGVs. CARB’s At Berth Regulation requires regulated vessels to connect to shore power or use an alternative emissions control technology to reduce emissions while docked at berth at regulated California seaports.

STEP 2(A): CALIFORNIA’S OFF-ROAD CONTROL MEASURES

Emission reductions from ongoing implementation of the current off-road control program are projected to reduce emissions of NOx by over 47 percent between today and 2030, emissions of direct PM by over 44 percent between today and 2030, and emissions of ammonia by approximately 15 percent between today and 2030. Achieving reductions in the off-road sectors remains a greater challenge than in the on-road sector

due to the diverse nature of these sources, regulatory authority that rests outside of CARB in many cases, and the length of time sources remain in the fleet.

Figure 5: Off-Road Control Measures



The major regulatory and programmatic control measures that provide these emissions reductions are described below.

NEW VEHICLE, EQUIPMENT, AND ENGINE STANDARDS

Internal Combustion Off-Road Equipment (General)

To control emissions from off-road equipment, CARB adopted in 2004 a fourth tier of increasingly stringent PM and NOx standards based on the use of advanced aftertreatment emission controls. U.S. EPA also adopted the Tier 4 standards in 2004. California's current standards are equal in stringency to current federal standards. These ***"Tier 4" standards*** apply to new off-road compression-ignition engines, and were phased-in across product lines from 2008 through 2015 and reduced exhaust emission levels by up to 95 percent compared to previous control strategies. New engine standard requirements vary according to the power rating of engines. Table 19 shows the schedule for phasing in tiered requirements for new off-road engines with a power rating between 175 and 300 hp. Beginning in 2014, new Tier 4 construction equipment must emit about 96 percent less NOx and PM than new Tier 1 equipment sold in the year 2000.

Table 19: Phase-in of Off-Road Engine Standards

Model year	Level of Control	Applicable Emission Standard for New Off-road Engines 175<hp<300 g/bhp-hr	
		NOx	PM
1996-2002	Tier 1	6.9	0.4
2003-2005	Tier 2	4.9*	0.15
2006-2010	Tier 3	3.0*	0.15
2011-2013	Tier 4 interim	1.5	0.015
2014+	Tier 4 final	0.3	0.015
Under development	Tier 5 Standards	TBD	TBD

*Reflects combined limit for non-methane hydrocarbons and NOx

Moving beyond the stringency of emission controls required in the current control program, in the 2022 State SIP Strategy, CARB committed to ***Tier 5 Off-Road New Compression-Ignition Engine Standards***, which would establish more stringent standards and test procedures for new, off-road compression-ignition (CI) engines to reduce NOx, PM, and carbon (CO2) emissions (referred to as Tier 5) for all off-road engine power categories, including those that do not currently utilize exhaust aftertreatment such as diesel particulate filters (DPF) and selective catalytic reduction (SCR). CI engines are used in a wide range of off-road equipment including tractors, excavators, bulldozers, graders, and backhoes. As of model year 2020, more than half of all new off-road CI engine families continue to be certified to California's most stringent (Tier 4 final) emission standards without the need for DPFs. This means that most new off-road CI engines are not reducing toxic diesel PM to the greatest extent feasible using the best available technology. The proposed new Tier 5 standards and test procedures would be more stringent than required by current U.S. EPA and European Stage V nonroad regulations and would require the use of best available technologies for both PM and NOx. Lower NOx standards – up to 90 percent below the current Tier 4 final emission standard levels – coupled with lower PM standards, would force engine manufacturers to incorporate DPFs, which many currently do not have. DPFs would also ensure greater reductions in ultrafine PM, which may pose a health concern separate from PM emissions as a whole.

CARB has also engaged in a number of feasibility studies and technological demonstrations of the requisite technologies for this measure:

- CARB funded a research effort demonstrating the feasibility of advanced aftertreatment on 79 small off-road CI engines, which was completed by the Center for Environmental Research and Technology (CE-CERT) in 2019. Small off-road CI engines (less than 56-kilowatt [kW] or 75 hp) are not currently required to comply with advanced NOx aftertreatment-based standards, and a subset of these engines that are less than 19 kW (25 hp) are not required to comply with advanced PM aftertreatment--based standards. Small off-road CI engines account for between 20 to 40 percent of the off-road diesel PM and NOx emissions inventories in California.[96]

[96] "Evaluation of the feasibility, cost-effectiveness, and necessity of equipping small off-road diesel engines with advanced PM and/or NOx aftertreatment" – CARB Contract No. 14-300, March 2019, https://ww2.arb.ca.gov/sites/default/files/2020-10/14-300.pdf

- A recent research effort performed for CARB by CE-CERT concluded that current reporting and recordkeeping requirements are insufficient for determining the number of engines and equipment sold in California with less-stringent emission levels under both the federal Average, Banking, and Trading program and the federal Transition Program for Equipment Manufacturers.[97] Hence, it would be helpful to revise and improve the reporting and recordkeeping requirements.
- Recent CARB funded demonstrations of ultra-low NOx on-road engines conducted at the Southwest Research Institute (SWRI) show that much lower NOx standards are feasible for on-road engines. Because off-road diesel engines are similar in technology to on-road heavy-duty diesel engines, this work suggests that lower NOx standards are likely feasible for off-road engines as well. Additionally, CARB is currently funding an off-road demonstration project with SWRI to support determining the feasibility of more stringent off-road standards for NOx, PM, and CO2.
- Recent CARB test data, consistent with test data presented by reputable diesel publications, indicate that up to 40 percent of a typical off-road CI engine's in-use operation occur at idle,[98] and that the frequency of in-use low-load- operation[99] is insufficient to keep exhaust emission aftertreatment temperature above 250 degrees Celsius, that enables efficient SCR operation to control NOx emissions. Establishing new idle emission reduction strategies and a low-load test cycle are also being investigated as part of this Tier 5 measure.

Under this measure, CARB would develop and propose standards and test procedures for new off-road CI engines including the following: aftertreatment-based PM standards for engines less than 19 kW (25 hp), aftertreatment-based NOx standards for engines greater than or equal to 19 kW (25 hp) and less than 56 kW (75 hp), and more stringent PM and NOx standards for engines greater than or equal to 56 kW (75 hp) and first time CO2 tailpipe standards targeting a 5 to 8.6 percent reduction. Other possible elements include enhancing in-use compliance, proposing more representative useful life periods, idle requirements and developing a low load test cycle. It is expected that Tier 5 requirements would rely heavily on technologies manufacturers are developing to meet the recently approved low-NOx standards and enhanced in-use requirements for on-road- heavy-duty engines.

Zero-Emission Off-Road Equipment (General)

CARB anticipates increasing the stringency of Off-Road engine requirements through a rule requiring Zero-Emission manufacturer requirement. With the ***Off-Road Zero-Emission Targeted Manufacturer Rule*** measure, a commitment in the 2022 State SIP Strategy, CARB would accelerate the development and production of zero-emission off-road equipment and powertrains into more sectors (including wheel

[97] "Evaluation of the Impacts of Emissions Averaging and Flexibility Programs for all Tier 4 Final Off-road Diesel Engines," CARB Contract No. 14-301, February 2018, https://ww2.arb.ca.gov/sites/default/files/classic//research/apr/past/14-301.pdf?_ga=2.127732621.1682659074.1620315165-1165705998.1587147934

[98] https://www.constructionequipment.com/home/blog/10727772/thinking-through-fuel-burn-rates

[99] Measurement of PM and Gaseous Emissions from Cargo Handling Equipment (CHE) during Real-World Operation – David Quiros, 29th CRC Real World Emissions Workshop, March 2019

loaders, excavators, and bulldozers) as technology advancements occur due to existing CARB zero-emission regulations and regulations in the forklifts, cargo handling equipment, off-road fleets, and small off-road engines sectors. For this measure, CARB would propose to develop a regulatory measure that would require manufacturers of off-road equipment and/or engines to produce for sale zero-emission equipment and/or powertrains as a percentage of their annual statewide sales volume to ensure these globally emerging zero-emissions products and related innovations come to California.

REDUCING IN-USE EMISSIONS

Fleet Rules: Off-Road Equipment (General)

Large diesel off-road equipment typically remains in use for long periods of time. As with heavy-duty trucks, this long life means that newer, lower-emitting engines would be introduced into fleets relatively slowly. To address this, ***the Cleaner In-Use Off-Road Equipment Regulation (Off-Road Regulation)*** was adopted in 2007, and amended in 2009 and 2010. The regulation covers all self-propelled off-road diesel vehicles 25 horsepower or greater used in California and most two-engine vehicles (except on--road two-engine sweepers). The Off-Road Regulation requires off-road fleets to reduce their emission by retiring, replacing, or repowering older engines. This Regulation expanded the penetration of existing clean technology to ensure that the engines and vehicles used today are as clean as possible. U.S. EPA approved this regulation in 2013. The types of off-road equipment controlled by this regulation are used in construction, manufacturing, the rental industry, road maintenance, airport ground support, and landscaping. In December 2011, the Off-Road Regulation was modified to include on-road trucks with two diesel engines.

The Off-Road Regulation is an extensive program designed to accelerate the penetration of the cleanest equipment into California's fleets. This regulation significantly reduces emissions of diesel PM and NOx from the over 150,000 in-use off-road diesel vehicles that operate in California by requiring their owners to modernize their fleets and install exhaust retrofits. The regulation requires that fleets meet an increasingly stringent set of fleet average targets, culminating in 2023 for large and medium fleets (large fleets represent about 54 percent of vehicle ownership) and in 2028 for small fleets. The most stringent fleet average target generally corresponds to roughly a 2012 model year, or a Tier 3 average standard. In 2015, the program reduced emissions from 10,447 vehicles used in 838 fleets by requiring owners to modernize their fleets by replacing older engines or vehicles with newer, cleaner models, retiring older vehicles or using them less often, or by applying retrofit exhaust controls. The Off-Road Regulation imposes idling limits on off-road diesel vehicles, requires a written idling policy, and requires a disclosure when selling vehicles. The Regulation also requires that all vehicles be reported to CARB and labeled, restricts the addition of older vehicles into fleets, and requires fleets to reduce their emissions by retiring, replacing, or repowering older engines, or installing verified exhaust retrofits. The requirements and compliance dates of the Off-Road Regulation vary by fleet size.

With the ***2022 Amendments to the In-Use Off-Road Diesel-Fueled Fleets Regulation***, CARB further reduced emissions from the in-use off-road diesel equipment sector by increasing the stringency of the regulation's requirements. These amendments create additional requirements to the currently regulated fleets by targeting the oldest and dirtiest equipment that is allowed to operate indefinitely under the current regulation's structure. The amendments will require fleets to phase-out use of the oldest and highest polluting off-road diesel vehicles in California and prohibit the addition of high-emitting vehicles to a fleet. The amendments phase-in starting in 2024 through the end of 2036, and include changes to enhance enforceability and encourage the adoption of zero-emission technologies. The In-Use Off Road Diesel Fleets Regulation also requires the use of R99 or R100 renewable diesel in off-road diesel vehicles starting in January 2024 for all fleets.

CARB anticipates further emission reductions from the off-road equipment fleets through the ***Clean Off-Road Fleet Recognition Program measure***. This measure would create a non-monetary incentive to encourage off-road fleets to go above and beyond existing regulatory fleet rule compliance and adopt advanced technology equipment with a strong emphasis on zero-emission technology. This measure would provide a standardized methodology for contracting entities, policymakers, state and local government, and other interested parties to establish guidelines for contracting criteria or require participation in the program to achieve their individual policy goals. For this voluntary program, CARB would establish a framework that would encourage fleets to incorporate advanced technology and ZEVs into their fleets, prior to or above and beyond regulatory mandates. The program would provide standardized criteria or a rating system for fleet participation at various levels to reflect the penetration of advanced technology and ZEVs into a fleet. Levels could be scaled over time as zero-emission equipment becomes more readily available. CARB anticipates the next several years of technology advancements and demonstrations to drive the stringency of the rating system. Participation in the program would be voluntary for fleets; however, designed in a manner that provides them motivation to go beyond business as usual. The program would offer value for fleets to participate by providing them access to jobs/contracts, public awareness, and marketing opportunities.

Beyond the general fleet rules controlling emissions from off-road equipment, CARB has also developed and implemented control measures that target specific to categories of sources within the off-road sector, which are described below.

SOURCE-SPECIFIC RULES

Given the diversity of types of engines, vehicles, and equipment used in the off-road sector, CARB's control strategy includes multiple requirements that are specific to categories of sources within the off-road sector. This includes:

Agricultural Equipment

Emission Standards for Agricultural Equipment

In 2004, U.S. EPA and California adopted equivalent standards that require additional reductions from off-road engines, including engines used in mobile agricultural equipment. These ***Tier 4 Engine Standards*** continue to achieve substantial reductions in PM2.5 and NOx as new farm equipment is introduced into the fleet.

In-Use Controls: Agricultural Equipment

New engines used in agricultural equipment, primarily tractors, must meet the same standards as other off-road engines ensuring that new equipment becomes progressively cleaner. Just as in other off-road applications, diesel agricultural equipment can remain in use for long periods of time. This long life means that equipment with new, lower emitting engines are introduced into the fleet at a relatively slower pace than what is needed to meet air quality standards. CARB's ***Funding Agricultural Replacement Measures for Emission Reductions (FARMER) Program*** provides funding through local air districts for agricultural harvesting equipment, heavy-duty trucks, agricultural pump engines, tractors, and other equipment used in agricultural operations. Local air districts receive funds based on a formula and award them to farmers and agricultural businesses for individual projects.

Airport Ground Support Equipment (GSE)

Emission Standards for Airport GSE

Engines used in newly manufactured GSE operating on gasoline, LPG, and CNG are required to meet California's new engine emission standards for LSI. The ***LSI engine standard*** for engines greater than 1.0 liter (typical for GSE) is 0.6 g/bhp-hr of hydrocarbons (HC) and NOx. Engines meeting this standard are 70 percent cleaner than LSI engines produced as recent as 2009. Diesel engines in newly manufactured GSE must meet the Tier 4 emission standards applicable to off-road compression-ignition engines under the ***In-Use Off Road Diesel-Fueled Fleets Regulation***. These standards vary by horsepower and are more than 90 percent cleaner than the emissions levels of engines produced twenty years ago.

CARB is also anticipated to further increase the stringency of emission controls with the Zero-Emission Airport Ground Support Equipment measure, which will act as a catalyst to further adoption of zero-emission equipment in the off-road sector, facilitate the transfer of technology to suitable heavier duty-cycle applications, and expand use of zero-emission infrastructure.

In-Use Controls: Airport GSE

In addition to adopting regulations limiting emissions from new engines used in GSE, California has adopted regulations to reduce emissions from existing, in-use GSE. In 2007, California adopted the ***In-Use Off-Road Diesel-Fueled Fleets Regulation,*** which requires fleets operating in-use diesel equipment to meet an annual fleet average emissions target that decreases over time. For example, for equipment over 175 and under 750 HP, the final 2023 NOx fleet average target is 1.5 g/bhp hr, which is

equivalent to the interim Tier 4 NOx standard for newly produced engines. Fleets that do not meet the required annual fleet average must meet the BACT requirements that require turnover, repower or retrofit of a specific percent of a fleet's total HP. These requirements are currently being phased in. Additionally, fleets operating LSI GSE must meet the ***In-Use LSI Engine Fleet Requirements***. Adopted in 2006, the LSI fleet rule requires GSE fleets to maintain an average emission level of no more than 2.5 g/bhp hr HC+NOx, starting January 1, 2013. Non-mobile GSE such as portable air-start units, ground power units and air conditioners may be subject to the ***Portable Diesel-Engines Air Toxic Control Measure*** (ATCM). The ATCM reduces PM emissions by requiring engine replacement in a schedule based on a fleet's weighted PM emission average.

CARB is also anticipated to further increase the stringency of emission controls with the ***Zero-Emission Airport Ground Support Equipment measure***, a measure committed to in the 2016 State SIP Strategy, which will act as a catalyst to further adoption of zero-emission equipment in the off-road sector, facilitate the transfer of technology to suitable heavier duty-cycle applications, and expand use of zero-emission infrastructure.

Cargo Handling Equipment (CHE)

Emission Standards for Airport CHE

California's ***Cargo Handling Equipment Regulation*** set performance standards for engines in newly acquired, as well as in-use, mobile CHE at ports or intermodal rail yards in California. Mobile CHE is used to transfer goods or perform maintenance and repair activities and includes equipment such as yard trucks (hostlers), top handlers, side handlers, reach stackers, forklifts, rubber-tired gantry cranes, dozers, excavators, loaders, and railcar movers used in maintenance operations at ports and intermodal rail yards. CARB's CHE Regulation was originally adopted in 2005 to establish BACT requirements for new and in-use cargo handling equipment that operate at California's ports and intermodal rail yards, and was amended in 2011 to include opacity monitoring requirements. CARB obtained authorization for the 2005 version of the regulation in 2012. Under the CHE Regulation, all newly purchased yard truck and non-yard truck equipment brought onto a port or intermodal rail yard must have either a Tier 4 Final off-road engine or an on-road engine meeting the 2010 or newer on-road emission standards. CHE Regulations set performance standards for engines in newly acquired, as well as in-use, mobile CHE at ports or intermodal rail yards in California.

CARB staff anticipates increasing the stringency of emission standards for CHE with the ***Amendments to CHE Regulation***. In March 2018, CARB staff presented to the Board a plan to begin development of a regulation to transition CHE to zero-emission technologies, and to minimize emissions and community health impacts from cargo handling equipment. The CHE amendments would set in-use requirements for diesel cargo handling equipment at ports and rail yards, including but not limited to yard trucks (hostlers), rubber-tired gantry cranes, container handlers, and forklifts. The regulatory amendments would propose to start transitioning CHE to zero-emission with an implementation schedule for new equipment and facility infrastructure requirements,

with effective dates beginning in 2026. Staff would assess the availability and performance of zero-emission technology as an alternative to all combustion-powered cargo equipment and evaluate additional solutions that may include efficiency improvements. Based on the current state of zero-emission CHE technological developments, the transition to zero-emission would most likely be achieved largely through the electrification of CHE. In this potential action, all mobile equipment at ports and rail yards, including but not limited to diesel, gasoline, natural gas, and propane-fueled equipment, would be subject to new requirements. Staff anticipates that all yard trucks and forklifts would be zero-emission by 2030, rubber-tired gantry cranes would be zero-emission by 2032, and 90 percent of other CHE will be zero-emission by 2036. These assumptions are supported by the fact that currently some electric rubber tire gantry cranes, electric forklifts, and electric yard tractors are already commercially available. Other technologies are in early production or demonstration phases. CARB staff would also consider opportunities to prioritize the earliest implementation in or adjacent to the communities most impacted by air pollution. Board consideration for adoption of these amendments is anticipated in 2024.

In-Use Controls: CHE

As described earlier, the ***Cargo Handling Equipment Regulation*** (adopted in 2005, amended in 2011) includes performance standards for in-use, mobile CHE at ports or intermodal rail yards in California. CARB's CHE Regulation was originally adopted in 2005 to establish BACT requirements for new and in-use cargo handling equipment that operate at California's ports and intermodal rail yards, and was amended in 2011 to include opacity monitoring requirements. CARB obtained authorization for the 2005 version of the regulation in 2012. Under the CHE Regulation, all legacy in-use non-yard truck engines that are still in service (Tier 0 – Tier 3) must have a Verified Diesel Emission Control Strategy (VDECS) installed.

CARB anticipates increasing the stringency of in-use requirements with the CHE measure committed to in the 2022 State SIP Strategy. CARB's proposed ***Amendments to the Cargo Handling Equipment Regulation*** would set in-use requirements for diesel cargo handling equipment at ports and rail yards, including but not limited to yard trucks (hostlers), rubber-tired gantry cranes, container handlers, and forklifts. Staff would assess the availability and performance of zero-emission technology as an alternative to all combustion-powered cargo equipment and evaluate additional solutions that may include efficiency improvements. The regulatory amendments would propose an implementation schedule for new equipment and facility infrastructure requirements, with effective dates beginning in 2026.

Commercial Harbor Craft (CHC)

Emission Standards and in-use controls for CHC

The ***Commercial Harbor Craft Regulation*** reduces diesel PM and NOx emissions from a number of types of CHC operating in California. CARB's 2008 and 2011 CHC

Regulations required NOx and diesel PM emission controls on crew and supply boats, ferries, excursion vessels, towboats, push boats, tug boats, barges, and dredges.

CARB adopted the ***Amended CHC Regulation in 2022***, establishing expanded and more stringent in-use requirements to cover more vessel categories, including all tank barges, pilot vessels, research vessels, workboats, commercial passenger fishing, and commercial fishing vessels. The amendments also mandate accelerated deployment of zero-emission and advanced technologies in vessel categories where technological feasibility has been demonstrated. Starting in 2023 and phasing in through 2031, most CHC (except for commercial fishing vessels and categories listed below) are required to meet the cleanest possible standard (Tier 3 or 4) and retrofit with DPF based on a compliance schedule. The current regulated CHC categories are ferries, excursion, crew and supply, tug/tow boats, barges, and dredges. The amendments impose in-use requirements on the rest of vessel categories except for commercial fishing vessels, including workboats, pilot vessels, commercial passenger fishing, and all barges over 400 feet in length or otherwise meeting the definition of an ocean-going vessel. The amendments also remove the current exemption for engines less than 50 horsepower. Starting in 2025, all new excursion vessels are required to be plug-in hybrid vessels that are capable of deriving 30 percent or more of combined propulsion and auxiliary power from a zero-emission tailpipe emission source. Starting in 2026, all new and in-use short run ferries are required to be zero-emission; and starting in 2030 and 2032, all commercial fishing vessels need to meet a Tier 2 standard at minimum. The 2022 Amendments to the Commercial Harbor Craft (CHC) Regulation also require the use of at least 99 percent Renewable Diesel ("R100" or "R99"). The use of renewable diesel in CHC will achieve additional emission reductions to the already reduced emissions from Tier 3 or Tier 4 engines plus diesel particulate filters (DPF). Renewable diesel has been required to be used by all CHC operating in the State as of January 1, 2023.

Forklifts

Emission Standards for Forklifts

Forklifts operate in many different industry sectors but are most prevalent in manufacturing and at locations such as warehouses, distribution centers, and ports. Diesel-fueled forklifts were first subject to engine standards and durability requirements in 1996. The most recent ***Tier 4 Final emission standards*** were phased in starting in 2013. Tier 4 emission standards are based on the use of advanced after-treatment technologies such as diesel particulate filters and selective catalytic reduction. Forklifts powered by LSI engines (gasoline and natural gas) have been subject to new engine standards that include both criteria pollutant and durability requirements since 2001, with the cleanest requirements phased-in starting in 2010.

CARB staff anticipates further increases to the stringency of emission controls with the ***Zero-Emission Off-Road Forklift Regulation Phase I measure***, a commitment from the 2016 State SIP Strategy, which would accelerate the deployment of zero-emission forklift technologies. The regulatory amendments would propose requirements that prohibit the new purchases of LSI forklifts, with an implementation schedule beginning in 2026. Forklifts are also subject to further controls under the ***Off-Road Zero-Emission***

Targeted Manufacturer Rule measure, which CARB committed to in the 2022 State SIP Strategy. This measure would accelerate the deployment of zero-emission forklifts through a measure requiring manufacturers to produce zero-emission equipment and/or powertrains as a percentage of their sales volume.

In-Use Controls: Forklifts

Forklift fleets are subject to both the ***LSI Fleet Regulation*** (if powered by gasoline or propane), and the ***Off-Road Diesel Fleet Regulation*** (if powered by diesel) are required to retire, repower, or replace higher-emitting equipment in order to maintain fleet average standards. The ***Off-Road Diesel Regulation*** was adopted by the Board in 2007 with implementation beginning in 2010. It is applicable to all diesel-fueled, self-propelled off-road equipment with at least 25 HP. Forklifts are included in the fleet average along with other equipment. Additionally, the ***LSI fleet Regulation*** (which was originally adopted with requirements beginning in 2009) requires fleets with four or more LSI forklifts to meet fleet average emission standards. While the LSI fleet Regulation applies to forklifts, tow tractors, sweeper/scrubbers, and airport ground support equipment, it maintains a separate fleet average requirement specifically for forklifts.

With the recent adoption of the ***2022 Amendments to the In-Use Off-Road Diesel-Fueled Fleets Regulation,*** forklifts are also subject to begin transitioning to zero-emission technologies. Beginning in 2024, requirements begin to transition fleets from the oldest and highest-emitting off-road engines in operation in California by phasing out Tier 0 – Tier 2 equipment. Also beginning in 2024, the regulation includes requirements to restrict the addition of new vehicles and/or engines with Tier 3 and 4i engines, which is an expansion of the provisions of the current regulation, which restrict the vehicle-engine tiers that can be added to a fleet. The regulation also includes elements that require contracting entities to obtain and retain a fleet's valid Certificate of Reported Compliance prior to awarding a contract or hiring a fleet, mandate the use of R99 or R100 Renewable Diesel for all fleets, with some limited exceptions; provide voluntary compliance flexibility options for fleets that adopt zero-emission technology; and include additional requirements to increase enforceability, provide clarity, and provide additional flexibility for permanent low-use vehicles.

CARB is anticipated to further increase the stringency of in-use emission controls for forklifts with the ***Zero-Emission Off-Road Forklift Regulation Phase I measure,*** a measure committed to in the 2016 State SIP Strategy, which would be designed to accelerate the deployment of zero-emission forklift technologies. The regulatory amendments would propose requirements for fleets to retire existing LSI forklifts that are 13 years and older, and would propose an implementation schedule beginning in 2026. Under the ***Amendments to the Cargo Handling Equipment Regulation measure***, which CARB committed to in the 2022 State SIP Strategy, forklifts operating at ports and intermodal rail yards would also be subject to begin transitioning to zero-emission technologies. Staff anticipates that all forklifts operating at ports and intermodal rail yards would be zero-emission by 2030, which is supported by the fact

that currently some electric forklifts are already commercially available, with other technologies are in early production or demonstration phases.

Marine Engines

Emission Standards for Marine Engines

U.S. EPA first promulgated exhaust emission standards to reduce emissions of HC and NOx from new outboard and personal watercraft engines in 1996, which were to begin in 2006. In 1998, CARB adopted the ***Exhaust Emission Regulations for Spark-Ignition Marine Engines***, which accelerated the federal standard's 2006 implementation date to 2001 in California, and also set more stringent California standards for outboard and personal watercraft engines that took effect in 2004 and 2008. In 2001, CARB amended the ***Spark-Ignition (SI) Marine Regulations*** to include HC+NOx emission standards for new sterndrive and inboard marine engines. These standards adopted Tier I and ***Tier II emission standards for inboard and stern-drive marine engines***. In 2007, U.S. EPA harmonized with CARB's accelerated implementation schedule and more stringent exhaust standards for outboard and personal watercraft engines, and also granted California authorization to enforce CARB's regulations for Outboard Engines and Personal Watercraft engines and Tier I of the California inboard and stern-drive marine engine emissions standards. In 2011, U.S. EPA granted California authorization to enforce CARB's Tier II exhaust emission standards for spark ignited inboard and stern-drive marine engines. The Tier II Emission Standards for Inboard and Stern-Drive Marine Engines (2001) controls emissions at the same level of stringency as national regulations. While CARB has the same exhaust emission standards as the federal standard, the California standard applies to engines sooner, starting in 2008 rather than 2010 under the federal requirement.

In February 2015, CARB Board approved more stringent ***Evaporative Emission Control Standards*** than those set forth by the U.S. EPA's 2008 rule for gasoline-fueled spark-ignition marine watercraft configured with engines greater than 30 kilowatts. The Evaporative Emission Control Standards (2015) exceeds the stringency of applicable national regulations set by U.S. EPA in 2008 for gasoline-fueled spark-ignition marine watercraft >30 kilowatts.

CARB anticipates proposing further increases in stringency for Spark-Ignition Marine Engine Standards. The ***Spark-Ignition Marine Engine Standards measure*** from the 2022 State SIP Strategy would reduce emissions from new spark-ignition (SI) marine engines by adopting more stringent exhaust standards for outboard and personal watercraft, which currently do not use catalyst control technologies. Staff estimates that stricter standards could reduce combined HC or ROG and NOx emissions by approximately 70 percent below the current HC+NOx standard (≈16.5 grams per kilowatt-hour (g/kW-hr)) for engines greater than or equal to 40 kilowatts (kW) in power, and by approximately 40 percent for engines less than 40 kW in power. CARB staff is also evaluating whether some outboard and personal watercraft vessels could be propelled by zero-emission technologies in certain applications. For example, zero-

emission powertrains have the potential to gradually replace most outboard engines less than 19 kW, as well as many new personal watercraft engines.

Off-Highway Recreational Vehicles (OHRV)

Emission Standards for OHRV

Off-road recreation vehicles, also known as off-highway recreational vehicles (OHRV), primarily include off-highway motorcycles, all-terrain vehicles (ATVs), and utility-terrain vehicles, off-road sport and utility vehicles, sand cars, and golf carts. In 1994, CARB adopted its first OHRV regulation, which established ***exhaust emission standards for OHRVs***. At that time, there were no equivalent federal standards regulating exhaust emissions from the vehicles and engines covered by California's OHRV regulations (U.S. EPA first set exhaust emission limits for OHRVs in 2002). U.S. EPA granted authorization for CARB's 1994 OHRV regulations in 1996. CARB subsequently amended the regulations to increase the stringency of controls and expand the categories of OHRVs controlled under the program; first in 1999, subsequently in 2003, and again in 2006. All three OHRV Engine Emission Standard amendments were granted authorization concurrently by U.S. EPA in 2014.[100]

The 2006 amendments to CARB's OHRV program also set ***evaporative emission standards***, establishing a fuel tank permeation limit of 1.5 grams per square meter per day (g/m^2/day) of total organic gas (TOG) for a 3-day diurnal period, and a fuel hose permeation limit of 15 g/m^2/day. At the time, these limits were identical to the national limits set by U.S. EPA. In July 2013, CARB adopted more stringent evaporative emission control standards for OHRVs that established a new test procedure and reduced evaporative emission limits to 1.0 g/m^2/day. Authorization was granted by U.S. EPA in 2017.[101]

In 2019 the Board approved more stringent exhaust regulations for OHRVs, which set more stringent exhaust emission control standards for ATVs, off-road sport vehicles, and off-road utility vehicles for MY 2022 – 2027, and more stringent evaporative regulations for OHRVs, which harmonize with U.S. EPA evaporative emissions standards for OHMC for MY 2020 – 2026. The 2019 Amendments also included provisions to accelerate the development of zero-emission OHRVs, and set more stringent California-specific emissions standards for all new OHRV beginning with MY 2027 for evaporative emission standards, and with MY 2028 for exhaust emission standards.

In-Use Controls: OHRV

In 1994, CARB set exhaust standards for all OHRV that were to go into effect starting in 1998. The exhaust standards were technology forcing, and additional time was needed for manufacturers to produce a full range of compliant vehicles. Dealers expressed

[100] U.S. EPA, 2014. "California State Nonroad Engine Pollution Control Standards; Off-Highway Recreational Vehicles and Engines; Notice of Decision" https://www.gpo.gov/fdsys/pkg/FR-2014-02-04/pdf/2014-02297.pdf Federal Register, Vol. 79, No. 23

[101] U.S. EPA, 2017. "California State Nonroad Engine Pollution Control Standards; Evaporative Emission Standards and Test Procedures for Off-Highway Recreational Vehicles (OHRVs); Notice of Decision" https://www.gpo.gov/fdsys/pkg/FR-2017-01-19/pdf/2017-01259.pdf Federal Register, Vol. 82, No. 12

concern that certified models would not be available and that California OHRV dealerships would go out of business. In 1998, CARB met with affected stakeholders and developed a temporary compromise that allowed for the certification of vehicles that do not meet emissions standards. CARB adopted this compromise into regulation in 1999, which have become known as the ***Red Sticker Program***. It allows for certification and sale of OHRV that have no emissions control systems.

In order to reduce excess emissions, the 1999 Amendments established a new compliance category beginning with the 2003 model year, and designates OHRVs as either "green sticker" or "red sticker", depending on whether the engine meets or exceeds the applicable emission standard. Non-emission compliant OHRVs are identified with a red registration sticker issued from the Department of Motor Vehicles (DMV), while emission compliant OHRVs are identified with a green sticker. Red sticker OHRVs are subject to in-use restrictions that do not apply to green sticker OHRVs; namely, the red sticker limits operation at certain off-highway recreational vehicle parks located in ozone nonattainment areas during the summer months (i.e. peak ozone season).

The red sticker program was envisioned as a temporary measure to provide market stability while manufacturers developed a full range of OHRV that complied with California's emissions standards. This temporary measure has now been in effect for more than twenty years, and the majority of off-highway motorcycles sold in California are red sticker vehicles with no emissions controls. The 2019 Amendments to the OHRV program instituted actions to begin sunsetting the Red Sticker Program, including:

- Ending red sticker certification of new OHRV with no emissions controls beginning in model year 2022;
- Establishing transitional standards from 2020 through 2026; and
- Lifting the seasonal riding restrictions on existing red sticker vehicles starting on January 1, 2025.

Currently, this program is being phased-out to allow for more stringent emission control measures. In the meantime, however, the red-sticker program continues to control emissions from the in-use OHRV fleet.

Small Off-Road Equipment (SORE)

Emission Standards for SORE

Small Off-Road Engines (SORE) are spark-ignited engines rated at or below 19 kilowatts. This category includes handheld and non-handheld lawn and garden and industrial equipment such as string trimmers, leaf blowers, walk-behind lawn mowers, generators, and lawn tractors. They are used in applications such as lawn and garden, industrial, construction and mining, logging, airport ground support, commercial utility, and farm equipment, golf carts, and specialty vehicles. Staff estimates that there are approximately 16.5 million pieces of SORE equipment in California, the majority of which are spark-ignition (SI) engines used in residential and commercial lawn and garden applications, together with other utility and small industrial applications.

CARB first adopted ***SORE Exhaust Emission Standards and Test Procedures*** in 1990, with amendments in 1998 that increased the stringency and extended the types of engines and equipment applicable to the standard. In September 2003, CARB adopted more stringent exhaust emission standards***,*** and set the first ***Evaporative Emission Standards*** for SORE. Prior to the adoption of these standards, evaporative emissions were uncontrolled. U.S. EPA granted full authorization for this suite of regulations in 2006, and these more stringent standards were phased-in for model years 2006 through 2013.[102]

In 2010, CARB set ***Standards for Zero-Emission SORE Equipment***.[103] In 2011, CARB again amended the regulation, modifying CARB's existing test procedures and aligned California procedures to be consistent with U.S. EPA's amendments to the federal certification and exhaust emission testing requirements (see Title 40 CFR Parts 1054 and 1065.11). The 2011 Amendments also set ***Exhaust Emission Certification Test Fuel Amendments*** for using ethanol blends of up to 10 percent (E10) in Off-Road SI SORE Engines, if it is certified by U.S. EPA. U.S. EPA approved the full suite of 2011 Amendments in 2015.[104] In 2016, CARB amended its ***evaporative emission standards*** for the entire category of SORE to increase stringency.[105]

In 2021, CARB adopted amendments to the Small Off-Road Engine Regulations ***(2021 Amendments to the SORE Regulation)***. These amendments set SORE emission standards to zero in two phases:

- First, SORE emission standards are lowered to zero for model year (MY) 2024 and all subsequent model years by setting exhaust emission standards to zero (0.00 grams per kilowatt-hour or g·kWh-1). Evaporative emission standards are also set to zero (0.00 grams per test or g·test-1). The evaporative emission standards include "hot soak" emissions (representing emissions that occur when placing a hot engine in storage after use on a hot summer day) to better evaluate emissions from real-world use of SORE equipment. These emission standards of zero apply for engines used in all equipment types produced for sale or lease for operation in California, except pressure washers with engine displacement greater than or equal to 225 cubic centimeters and generators. Generator emission standards are more stringent than the existing emission standards starting in MY 2024, but would not be zero; and
- The second phase would be implemented starting in MY 2028, when the phase-in for zero-emission pressure washers and generators would begin.

In analyzing the feasibility of this regulation, CARB staff found that zero-emission equipment (ZEE) are available for most small off-road equipment categories, including

[102] U.S. EPA, 2006. "California State Non-road Engine and Vehicle Pollution Control Standards; Decision of the Administrator" https://www.gpo.gov/fdsys/pkg/FR-2006-12-15/pdf/E6-21378.pdf Federal Register / Vol. 71, No. 241
[103] CARB 2010. "Final Regulations Order" accessed June 2018 https://www.arb.ca.gov/regact/2008/sore2008/soreresubfro.pdf?_ga=2.218709145.1039751104.1528225837-29497060.1519676686
[104] U.S. EPA 2015. "California State Non-road Engine Pollution Control Standards; Small Off-Road Engines Regulations; Notice of Decision
[105] CARB 2016. "Final Regulations Order" accessed June 2018 https://www.arb.ca.gov/regact/2016/sore2016/finalreg.pdf?_ga=2.102358145.1039751104.1528225837-29497060.1519676686

lawn and garden equipment and utility equipment, for both residential and professional use. The level of performance, number of brands, and number of equipment options have increased greatly and continue to do so today. At present, there are at least 35 brands of zero-emission lawn mowers available, with several brands directed at professional users. While adoption rates for ZEE among professional landscapers are lower than for residential users, there is substantial evidence that all new small off-road equipment can be zero-emission. Using ZEE is technologically feasible and can offer significant cost-savings to professional users. There are at least 12 brands of zero-emission lawn and garden equipment designed for professional users available for sale.

Transport Refrigeration Units (TRU)

Emission Standards for TRU

TRUs are refrigeration systems powered by an internal combustion engine (inside the unit housing), designed to control the environment of temperature sensitive products that are transported in refrigerated trucks, trailers, railcars, and shipping containers. TRUs operate in large numbers at distribution centers, food manufacturing facilities, packing houses, truck stops, and intermodal facilities, and are used to haul perishable products including food, beverages, pharmaceuticals, flowers, medical products, industrial chemicals, and explosives. TRUs may be capable of both cooling and heating. They deliver perishable goods to retail outlets, such as grocery stores, restaurants, cafeterias, convenience stores, etc. Although TRU engines are relatively small (ranging from 9 to 36 hp) significant numbers of these engines congregate at distribution centers, truck stops, and other facilities, exacerbating air quality challenges and resulting in potential for health risks to those that live and work nearby. The growth rate of TRUs is tied to population, since food is the main product type that is hauled.

In 2022, CARB adopted amendments to the ***Airborne Toxic Control Measure (ATCM) for In-Use Diesel-Fueled TRUs and TRU Generator Sets (TRU ATCM)***, which include requirements that MY 2023 and newer trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines shall meet a PM emission standard of 0.02 grams per brake horsepower-hour or lower (aligns with the U.S. EPA Tier 4 final off-road PM emission standard for 25-50 horsepower engines).

In the 2022 State SIP Strategy, CARB committed to developing a subsequent ***Transport Refrigeration Unit Regulation Part 2*** measure, which would require zero-emission trailer TRUs, domestic shipping container TRUs, railcar TRUs, and TRU generator sets for future Board consideration. The new requirements would achieve additional emission and health risk reductions, increase the use of zero-emission technology in the off-road sector, and meet the directive of Governor Newsom's Executive Order N-79-20, which set a goal for 100 percent zero-emission off-road vehicles and equipment in the State by 2035 where feasible. For this measure, CARB would propose the Part 2 rulemaking to require trailer TRUs, domestic shipping container TRUs, railcar TRUs, and TRU generator sets to use zero-emission technology. CARB is currently assessing zero-emission technologies for trailer TRUs and the remaining TRU categories.

In-Use Controls: TRU

CARB adopted the ***Airborne Toxic Control Measure*** (***ATCM) for In-Use Diesel-Fueled TRUs and TRU Generator Sets (TRU ATCM)*** in 2004 (and amended it in 2010 and 2011) to reduce diesel PM emissions and resulting health risk from diesel-powered TRUs. The TRU regulations establish in-use performance standards for diesel-fueled TRUs and TRU generator sets which operate in California, and facilities where TRUs operate. The regulation is designed to reduce the diesel PM emissions from in-use TRU and TRU generator set engines that operate in California, using a phased-in implementation approach over about 12 years by requiring engines to meet in-use emission standards by the end of the seventh year after manufacture. Implementation of the TRU ATCM began in 2009, and applies to in-use diesel-fueled TRUs and TRU generator sets that operate in California, whether they are registered in or outside the State. U.S. EPA issued an authorization for the TRU regulation in 2009.[106] CARB subsequently amended the TRU ATCM in 2010 and again in 2011 to provide owners of TRU engines with certain flexibilities to facilitate compliance, clarify recordkeeping requirements, and establish requirements for businesses that arrange, hire, contract, or dispatch the transport of goods in TRU-equipped trucks, trailers, or containers. U.S. EPA authorized the 2010 Amendments in 2013 and the 2011 Amendments in 2017, respectively.[107, 108]

On February 24, 2022, CARB adopted ***Amendments to the TRU ATCM (2022 Amendments)*** to achieve additional emission and health risk reductions from diesel-powered TRUs and increase the use of zero-emission (ZE) technology in the off-road sector. Key elements of the 2022 Amendments include:

- **Zero-emission truck TRU requirement –** Beginning December 31, 2023, TRU owners shall turnover at least 15 percent of their truck TRU fleet (defined as truck TRUs operating in California) to ZE technology each year (for seven years). All truck TRUs operating in California shall be ZE by December 31, 2029.
- **Applicable facility requirements –** Beginning December 31, 2023, owners of refrigerated warehouses or distribution centers with a building size of 20,000 square feet or greater, grocery stores with a building size of 15,000 square feet or greater, seaport facilities, and intermodal railyards (applicable facilities) shall register the facility with CARB, pay fees every three years, and report all TRUs that operate at their facility to CARB quarterly, or alternatively attest that only compliant TRUs operate at their facility.
- **Expanded TRU reporting –** Beginning December 31, 2023, TRU owners shall report all TRUs (including out-of-state based) that operate in California to CARB.

[106] U.S. EPA, 2009. "California State Nonroad Engine and Vehicle Pollution Control Standards; Authorization of Transport Refrigeration Unit Engine Standards; Notice of Decision" Federal Register Volume 74, Number 11, pp. 3030-3033

[107] U.S. EPA, 2013. "California State Nonroad Engine Pollution Control Standards; Within-the-Scope Determination for Amendments to California's ''Airborne Toxic Control Measure for In-Use Diesel-Fueled Transport Refrigeration Units (TRU) and TRU Generator Sets and Facilities Where TRUs Operate''; Notice of Decision" https://www.gpo.gov/fdsys/pkg/FR-2013-06-28/pdf/2013-15437.pdf Federal Register Vol. 78, No. 125

[108] U.S. EPA, 2017. "California State Nonroad Engine Pollution Control Standards; In-Use Diesel-Fueled Transport Refrigeration Units (TRUs) and TRU Generator Sets and Facilities Where TRUs Operate; Notice of Decision" https://www.gpo.gov/fdsys/pkg/FR-2017-01-19/pdf/2017-01225.pdf Federal Register Vol. 82, No. 12

- **TRU operating fees and compliance labels –** Beginning December 31, 2023, TRU owners shall pay TRU operating fees and affix CARB compliance labels to their TRU every three years, for each TRU operated in California. Collected fees will be used to cover CARB's reasonable costs associated with the certification, audit, and compliance of TRUs.
- **Zero-emission truck TRU assurances –** Manufacturers of zero-emission truck TRUs shall be required to provide a comprehensive warranty for zero-emission truck TRUs and have an authorized service-and-repair facility located in California to perform warranty repairs.

In the 2022 State SIP Strategy, CARB committed to developing a subsequent ***Transport Refrigeration Unit Regulation Part 2***, which would require zero-emission trailer TRUs, domestic shipping container TRUs, railcar TRUs, and TRU generator sets for future Board consideration. The new requirements would achieve additional emission and health risk reductions, increase the use of zero-emission technology in the off-road sector, and meet the directive of Governor Newsom's Executive Order N-79-20, which set a goal for 100 percent zero-emission off-road vehicles and equipment in the State by 2035 where feasible. For this measure, CARB would propose the Part 2 rulemaking to require trailer TRUs, domestic shipping container TRUs, railcar TRUs, and TRU generator sets to use zero-emission technology. CARB is currently assessing zero-emission technologies for trailer TRUs and the remaining TRU categories.

PRIMARILY FEDERALLY AND INTERNATIONALLY REGULATED SOURCES

Locomotives

Emission Standards for Locomotives

Under the Act, U.S. EPA has the sole authority to establish emissions standards for new locomotives.[109] Locomotives are self-propelled vehicles used to push or pull trains, including both freight and passenger operations. Union Pacific Railroad (UP) and BNSF Railway (BSNF) are the two Class I, or major, freight railroads operating in California. There are also seven intrastate passenger commuter operators and up to 26 freight shortline railroads currently operating in California. UP and BNSF, however, generate the vast majority (90 percent) of locomotive emissions within the State, with most attributable to interstate line haul locomotives. UP and BNSF operate three major categories of freight locomotives, both nationally and in California. The first category is interstate line haul locomotives, which are primarily ~4,400 horsepower (HP). The second category is made up of medium-horsepower (MHP) locomotives, as defined by CARB as typically between 2,301 and 3,999 HP. MHP locomotives are typically older line haul locomotives that have been cascaded down from interstate service. And lastly, there are switch (yard) locomotives, specifically defined by U.S. EPA as between 1,006 and 2,300 HP. Locomotives operating at railyards and traveling throughout the nation are a significant source of emissions of diesel PM (which CARB has identified as a toxic air contaminant), NOx, and GHGs. These emissions often occur in or near densely

[109] 42 United States Code (U.S.C.) §7547, (a)(5)

populated areas and neighborhoods, exposing residents to unhealthy levels of toxic diesel PM, plus regional ozone and secondary PM2.5.

U.S. EPA has previously promulgated two sets of national locomotive emission regulations (1998 and 2008). In 1998, U.S. EPA approved national regulations that primarily emphasized NOx reductions through Tier 0, 1, and 2 emission standards. Tier 2 NOx emission standards reduced older uncontrolled locomotive NOx emissions by up to 60 percent, from 13.2 to 5.5 g/bhp-hr.

In 2008, U.S. EPA approved a second set of national locomotive regulations. Older locomotives, upon remanufacture, are required to meet more stringent PM emission standards, which are about 50 percent cleaner than Tier 0-2 PM emission standards. U.S. EPA refers to the PM locomotive remanufacture emission standards as Tier 0+, Tier 1+, and Tier 2+. The new Tier 3 PM emission standard (0.1 g/bhp-hr), for model years 2012-2014, is the same as the Tier 2+ remanufacture PM emission standard. The 2008 regulations also included new ***Tier 4 locomotive NOx and PM emission standards*** (2015 and later model years). U.S. EPA Tier 4 NOx and PM emission standards further reduced emissions by approximately 90 percent from uncontrolled levels.

Beyond the currently adopted levels of controls, CARB staff petitioned U.S. EPA in 2017[110] to promulgate by 2020 both Tier 5 national emission standards for newly manufactured locomotives, and more stringent national requirements for remanufactured locomotives, as committed to in the 2016 State SIP Strategy's ***More Stringent National Locomotive Emission Standards*** measure. This would reduce emissions of criteria and toxic pollutants, fuel consumption, and GHG emissions. CARB staff estimates that U.S. EPA could require manufacturers to implement the new locomotive emission regulations by as early as 2023 for remanufactures and 2025 for newly manufactured locomotives. As documented in the Final Technology Assessment for Freight Locomotives,[111] CARB staff believes the most technologically feasible advanced technology for near-term deployment is the installation of a compact aftertreatment system (e.g., combination of selective catalytic reduction (SCR) and diesel oxidation catalyst (DOC)) onto new and remanufactured diesel-electric freight interstate line haul locomotives. Newly manufactured locomotives can also be augmented with on-board batteries to provide an additional 10-25 percent reduction in diesel fuel consumption and GHG emissions to achieve the Tier 5 emission levels. On board batteries could also provide zero emission track mile capabilities in and around railyards to further reduce diesel PM and the associated health risks.

A new federal standard could also facilitate development and deployment of zero-emission track mile locomotives and zero-emission locomotives by building incentives for those technologies into the regulatory structure. The compact SCR and DOC aftertreatment system could also be retrofitted to existing Tier 4 locomotives to be able to achieve a Tier 4+ emissions standard, when Tier 4 locomotives are scheduled

[110] https://ww2.arb.ca.gov/resources/documents/us-epa-responds-carbs-petition-strengthen-locomotive-emission-standards
[111] Final Technology Assessment for Freight Locomotives available at: https://www.arb.ca.gov/msprog/tech/report.htm

for remanufacture (every 7 to 10 years). Based on the typical remanufacture schedule, all Tier 4 locomotives could potentially be retrofitted with aftertreatment between 2025 and 2037. Existing locomotives originally manufactured to meet Tier 2 or Tier 3 standards could also be upgraded with the same compact aftertreatment system upon remanufacture to achieve emissions equal to Tier 4 levels.

In-Use Controls: Locomotives

CARB has worked closely with the major railroads in California, together with other stakeholders, to develop innovative measures to reduce in-use emissions from locomotives, a major source of NOx and PM emissions in the South Coast, but a source category over which CARB has limited regulatory authority.

While emission standards for locomotives are set by U.S. EPA, CARB has accelerated reductions from these sources through efforts that have focused on cleaner fuel requirements, and increasing use of cleaner locomotives. CARB staff and the Class I railroads have also been implementing through the ***2005 Statewide Rail Yard Agreement for California Rail Yards,*** a Memorandum of Understanding (MOU) to accelerate the introduction of cleaner locomotives since 2010.[112] This agreement obligated the railroads to increase the use of idle control devices, lowered locomotive idle times to 15 minutes, and opened a collaboration to produce Health Risk Assessments on 18 major railyards in the State, which was completed in 2015.

CARB will also increase the stringency of controls on locomotive operations with the recently adopted ***In-Use Locomotive Regulation***, which the Board adopted in April 2023. This regulation will accelerate the adoption of advanced, cleaner technologies for locomotive operations, including zero-emission technologies, and includes:

- Starting in 2024: Spending Account
  Locomotive operators will be required to fund their own trust account based on the emissions created by their locomotive operations in California. The dirtier the locomotive, the more funds must be set aside. Spending Account funds would be used in the following manner:
  - Until 2030: to purchase, lease, or rent Tier 4 or cleaner locomotives, or for the remanufacture or repower to Tier 4 or cleaner locomotive(s).
  - At any time: to purchase, lease, or rent ZE locomotive(s), ZE capable locomotive(s), ZE rail equipment, or to repower to ZE locomotive(s) or ZE capable locomotive(s).
  - At any time: for ZE infrastructure associated with ZE locomotive(s), ZE capable locomotive(s), ZE rail equipment.
  - At any time: to pilot or demonstrate ZE locomotives or ZE rail equipment technologies.

[112] CARB 2005 "ARB/Railroad Statewide Agreement: Particulate Emissions Reduction Program at California Rail Yards" https://ww2.arb.ca.gov/sites/default/files/2020-06/2005%20MOU%20Remediated%2003102020.pdf

- Starting in 2030: In-Use Operational Requirements
  Only locomotives less than 23 years old will be able to be used in California. Switchers, industrial and passenger locomotives with original engine build dates of 2030 or newer would be required to operate in a ZE configuration in California. Freight line haul locomotives with original engine build dates of 2035 and newer will be required to operate in a ZE configuration in California.
- Starting in 2024: Idling Limit
  All locomotives with automatic shutoff devices (AESS) will not be permitted to idle longer than 30 minutes, unless for an exempt reason. Exemptions closely align with those described by U.S. EPA, and would be granted for reasons like maintaining air brake pressure to perform maintenance.
- Starting in 2024: Registration and Reporting
  Locomotives operating in the State will be required to register with CARB. Reporting includes and annual administrative payment. Locomotive activity, emission levels and idling data will be required to be reported annually.

Additionally, the ***1998 Locomotive NOx Fleet Average Emissions Agreement in the South Coast Air Basin (1998 MOU)***, signed by CARB, Union Pacific Railroad and BNSF Railway, accelerated the introduction of cleaner locomotives into the South Coast. Under the MOU, UP and BNSF agreed to operate locomotive fleets that meet an average Tier 2 NOx emission standard, beginning in 2010 and running through 2030.

Local air districts may also pursue indirect source rules for freight facilities that could result in reductions from this category. CARB staff is considering an indirect source rule suggested control measure to assist air districts.

Ocean-Going Vessels

Ocean-going vessels (OGVs) are large commercial vessel designed to transport cargo or passengers between ports. Ocean-going vessels are generally greater than 400 feet, weigh more than 10,000 gross tons, and have per-cylinder engine displacement of greater than 30 liter/cylinder, and can be a U.S. or foreign owned vessel. Due to the international nature of shipping, most ocean-going vessels are owned by foreign companies, but are still subject to California ocean-going vessel regulations when within 24 nautical miles (nm) of the California coastline (Regulated California Waters or regulatory boundary or zone) or at-berth in California ports. The main categories of ocean-going vessels that operate in and visit California include: container, refrigerated cargo (“reefer”), cruise (or “passenger”), auto carrier, roll on-roll off (“ro-ro”), tanker, bulk, and general cargo vessels.

Emission Standards for Ocean-Going Vessels

OGVs and emissions standards are largely regulated on an international level by the International Maritime Organization (IMO), which specifies new engine NOx standards and sets fuel sulfur limits; neither U.S. EPA nor CARB have the authority to set emission standards for OGVs.

The IMO's primary focus is reducing NOx and GHG emissions from OGVs. IMO marine engine standards for OGVs regulate NOx emissions only, with no PM standards in place. Tier I and II engine standards exist for any vessel with a keel-laid date beginning on January 1, 2000, and January 1, 2011, respectively. Stricter Tier III IMO marine engines, which achieve a significant reduction in NOx emissions (around an 80 percent reduction from Tier II) are currently required for any OGV with a keel-laid date of January 1, 2016, or later. However, due to the long lifespan of OGVs and the fact that OGVs with keel laid dates after January 1, 2016, are only required to have Tier III engines when sailing within Emission Control Areas (ECA), turnover to Tier III engines is slow and not expected for most vessel categories until 2030+.[113]

In-Use Controls: Ocean-Going Vessels

While California does not have the authority to regulate emission standards for OGVs, California does have the authority to set in-use requirements for marine vessels, including foreign-flagged vessels, when they are in RCW and visit our ports, to the extent such regulation is not preempted by federal law.

In 2008, CARB adopted the ***Ocean-Going Vessel Fuel Regulation***, "Fuel Sulfur and Other Operational Requirements for Ocean-Going Vessels within California Waters and 24 Nautical Miles of the California Baseline," which is designed to reduce PM, NOx, and sulfur oxide emissions from ocean-going vessels. The OGV Clean Fuel Regulation requires operators to use less polluting marine distillate fuels instead of heavy fuel oil in their diesel engines and auxiliary boilers while operating within Regulated California Waters. The fuel requirements require the use of either marine gas oil (MGO) or marine diesel oil (MDO) with a maximum sulfur limit of 1.5 percent, and the MDO has a maximum sulfur limit of 0.1 percent.

In 2007, CARB adopted the ***Ocean-Going Vessels At-Berth Regulation (At-Berth Regulation)***, with compliance deadlines that began in 2014. The At Berth Regulation reduces emissions from container ships, passenger ships, and refrigerated-cargo ships docked at six California ports: Los Angeles, Long Beach, Oakland, San Diego, San Francisco, and Hueneme. At berth, auxiliary engines are used by vessels to run power for lighting, ventilation, pumps, communication, heating, and other onboard equipment while a vessel is docked. The At-Berth Regulation requires that vessels turn off their auxiliary diesel engines and plug in to shore-based grid electrical power, or utilize alternative technologies to achieve comparable emission reductions. Under the 2007 regulation, compliance requirements for vessels include visit requirements and emission or power reduction requirements, both which were phased in over time. More specifically, the regulation set an 80 percent reduction requirement, meaning a fleet must reduce its auxiliary engine power by 80 percent from the fleet's baseline power generation during the vessel's stay on 80 percent of the fleet's annual vessel visits. Under the 2007 Regulation, container, reefer, and cruise vessel fleets that make 25 visits or more per calendar year to a regulated port, and cruise vessels that make 5 or

[113] California Air Resources Board. Staff Report: Initial Statement of Reasons. October 15, 2019. https://ww2.arb.ca.gov/sites/default/files/classic/regact/2019/ogvatberth2019/isor.pdf

more visits per year to a regulated port, were subject to the requirements. Smaller vessel fleets (i.e., fleets that are comprised of container and reefer vessels that make fewer than 25 visits or cruise with fewer than 5 visits) and vessels that do not often frequent California ports were exempt from the 2007 Regulation.

CARB amended the At-Berth Regulation in 2020 to introduce emission control requirements to additional ports and terminals, including marine terminals that operate independently from a port or port authority, and to cover vessels exempted from the 2007 Regulation. This fulfilled a commitment in the 2016 State SIP Strategy to amend the 2007 At-Berth Regulation. The 2020 Amendments achieve additional emissions reductions of NOx, diesel particulate matter, PM2.5, ROG, and GHG emissions. Under the 2020 Amendments, the At-Berth Regulation was expanded to:

- require vessels to control at-berth emissions at additional ports and terminals;
- cover roll-on/roll-off and tankers;
- add compliance requirements for small fleets;
- Include previously exempted auxiliary engines that operate on liquefied natural gas (LNG) or other alternative fuels;
- Require tankers operating boiler steam powered pumps (for off-loading cargoes like crude oil) to control their boiler emissions;
- Require all regulated vessel visits to use a CARB approved emissions control strategy to reduce auxiliary engine emissions and boiler emissions on every visit to a regulated terminal; and
- Require all vessels visiting California, regardless of port and terminal applicability, to maintain opacity standards at berth and at anchor.

The 2020 Amendments also streamlined the regulatory structure while adding reporting and compliance requirements.

Reduced vessel speeds also provide emission reduction benefits, and programs are operated by local air districts along the California coast to incentivize lower speeds. CARB staff received comments during the public process for the 2022 State SIP Strategy about including a statewide vessel speed reduction program. In the 2022 State SIP Strategy, the CARB measure for ***'Future Measures for Ocean-Going Vessel Emission Reductions'*** considers options available under CARB authority to achieve further emissions reductions of NOx, PM, and GHG emissions from OGVs through the use of operational changes and new technologies currently in development, including advances in exhaust capture and control, mobile shore power connections, cleaner fuels (such as LNG, hydrogen, methanol, ammonia, etc.), alternative power sources (including batteries and fuel cells), as well as potential vessel side technologies (such as water-in-fuel emulsion). In pursuing regulatory measures, CARB would work with U.S. EPA, California air districts, seaports, and industry stakeholders in a collaborative effort to determine which measure would provide the most effective emissions reductions, as well as CARB's ability to implement each potential measure. Advocacy at the federal and international levels are necessary to achieve additional emissions

reductions from OGVs given the international nature of sea trade. Incentives or regulatory measures may be pursued to achieve emissions reductions from using cleaner engines or cleaner fuels, reducing emissions while anchored within RCW, sailing at slower speeds while in RCW, and requiring bulk/general cargo vessels to reduce emissions at berth.

Aircraft

In-Use Controls: Aircraft

NOx emissions from aircraft are projected to grow significantly. In California, aircraft are projected to make up 9.5 percent of mobile source NOx emissions in 2035, increasing from 5.4 percent in 2020.[114] According to CARB's emissions inventory, five different aircraft categories contribute significantly to NOx emissions: civilian piston aircraft, agricultural crop-dusting aircraft, military jet aircraft, commercial jet aircraft, and civilian jet aircraft. Commercial jet aircraft contribute about 90 percent of NOx emissions from all aircraft in California, whereas military jet aircraft and civilian jet aircraft each contribute about 4.5 percent of NOx. Together, civilian piston aircraft and agricultural crop-dusting aircraft produce less than 1 percent of NOx emissions.

The International Civil Aviation Organization (ICAO) is the United Nations body that sets and adopts civil aviation standards and practices for its 193 national government members. The Committee on Aviation Environmental Protection (CAEP) is a technical committee of ICAO. CAEP assists ICAO with formulating new policies and adopting new standards and recommended practices. The most recent standards adopted by ICAO are:[115]

- CAEP/8: latest NOx standard adopted in 2011;
- CAEP/10: first CO2 standard adopted in 2017; and
- CAEP/11: first non-volatile PM mass and number standard adopted in 2019.

U.S. EPA is required to set emission standards for any air pollutant emitted by aircraft that may reasonably be anticipated to endanger public health or welfare.[116] U.S. EPA is not bound by ICAO standards and can adopt standards that are stricter than those set by ICAO. U.S. EPA has historically adopted ICAO standards and has most recently adopted a GHG emission standard and has proposed a PM emission standard for aircraft that are both equivalent to the ICAO standards.

The Federal Aviation Administration's (FAA) Continuous Low Energy, Emissions, and NOISE (CLEEN) Program is a cost-sharing program aimed at accelerating the development and commercialization of new certifiable aircraft technologies and sustainable aviation fuels. The program has been successful in developing technologies relating to composite airframe technologies, advanced wing technologies, advanced fan

[114] CARB 2022 State SIP Strategy https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf
[115] Committee on Aviation Environmental Protection (CAEP) (icao.int) https://www.icao.int/ENVIRONMENTAL-PROTECTION/Pages/CAEP.aspx
[116] Clean Air Act sec. 231, 42 U.S.C. § 7571.

systems, and many other technologies.[117] There are certified aircraft engines available that achieve NOx emissions below the CAEP/8 standard and PM emissions below the latest CAEP/11 standard. Engine manufacturers are also currently developing engines that achieve significant reductions beyond the current standards. These new technology advances enable reductions in both NOx and PM emissions and provide a pathway for achieving effective ways to reduce harmful emissions.

Included in the 2022 State SIP Strategy was the ***Future Measures for Aviation Emission Reductions***, which committed CARB to strongly advocating for stricter emission regulations from U.S. EPA, while also exploring other opportunities under State authority to set reporting and/or operational requirements that can contribute to emissions reductions from aircraft. The Future Measures for Aviation Emissions Reductions measure was committed to in the 2022 State SIP Strategy. It would reduce emissions from airport and aircraft related activities, including main aircraft engines, auxiliary power units (APU), and airport ground transportation. As a part of this measure, CARB would explore requiring all larger airports to perform a comprehensive and standardized emission inventory. An accurate emission inventory that reflects all on-ground and near-ground emissions would establish a baseline and enable verifiable and quantifiable future emissions reductions. CARB would continue to assess technology development for the aviation sector. The purpose is to help inform and support CARB planning, regulatory, and voluntary incentive efforts. Concurrently, CARB would support, track, and explore current, in-development, and future emission reduction technology advancements. CARB would further evaluate federal, State, and local authority in setting operational efficiency practices to achieve emissions reductions. Operational practices include landing, takeoff, taxi, and running the APU, and contribute to on-ground and near-ground emissions. CARB would similarly work with U.S. EPA, air districts, airports, and industry stakeholders in a collaborative effort to develop regulations, voluntary measures, and incentive programs.

FUELS

In addition to new engines and in-use standards, cleaner burning fuels represent an important component in reducing emissions from the off-road mobile fleet. Cleaner fuel has an immediate impact in reducing emissions from the mobile source, and thus represent an important component in reducing NOx and PM emissions from off-road engines. California's stringent air quality programs treat mobile sources and their fuels holistically (as a system, rather than as separate components). As a result, CARB's fuels programs achieve significant reductions in criteria emissions from vehicles and mobile engines used in California.

CARB Diesel Fuel Regulations

The California diesel fuel program sets stringent standards for diesel fuel sold in California and produces cost-effective emission reductions from diesel-powered

[117] FAA, CLEEN Phase I and II Projects, Feb. 27, 2020, available at https://www.faa.gov/about/office_org/headquarters_offices/apl/eee/technology_saf_operations/cleen

vehicles. More stringent fuel requirements further ensure that diesel engines are operating as cleanly as possible. ***CARB Diesel Fuel Regulations*** have, over time, phased in more stringent requirements for fuel mixture specifications for aromatic hydrocarbons and sulfur, and have establish a lubricity standard. The program applies to sales of fuel used in on-road vehicles and off-road vehicles and locomotives in California. ***"CARB diesel" Specifications*** adopted in 1988 limited the allowable sulfur content of diesel fuel 500 parts per million by weight (ppmw), and the aromatic hydrocarbon content to 10 percent, and became effective in 1993.

U.S. EPA began regulating sulfur content in diesel in 1993. At that time, uncontrolled fuels (i.e. non-CARB diesel) contained approximately 5,000 parts per million (ppm) of sulfur. In 2006, U.S. EPA began to phase-in more stringent requirements under the federal Ultra-Low Sulfur Diesel (ULSD) regulations, which lowered the amount of sulfur in on-road diesel fuel to 15 ppm. U.S. EPA's Nonroad Diesel Fuel Standards were phased in from 2007 to 2014, and require that all off-road engines, including those used in locomotives and off-road equipment, use ULSD fuel (with some exemptions for older locomotives and marine engines). The Nonroad Standards also require that diesel fuel sold into the market for off-road use must be ULSD. It is important to note that while U.S. EPA defines ULSD as ≤ 15 ppm for on-road applications, the definition of off-road ULSD is significantly less stringent, defined as ≤ 500 ppm standard.

In 2003, ***CARB's Ultra Low Sulfur Diesel (ULSD) Regulation*** increased the stringency of the sulfur content limits in to 15 ppm, which began implementation in 2006. CARB's ULSD Regulation had an immediate impact in reducing emissions from the in-use fleet, while also enabling the use of advanced emissions control technologies, including the use of catalyzed diesel particulate filters, NOx after-treatment, and other advanced after-treatment based emission control technologies that higher sulfur levels would have inhibit the performance of (at the time of CARB's ULSD rulemaking, the average sulfur content of California diesel was approximately 140 ppmw). The original applicability of the regulations was to vehicular diesel fuel; however, the applicability of the regulations has been extended by the adoption of ATCMs to non-vehicular diesel fuel, such as fuel for stationary engines, locomotives, and marine harbor craft.

Beyond the current fuels control program, CARB committed to develop a ***Low Emission Diesel*** Measure in the 2016 State SIP Strategy that will require diesel fuel providers to steadily decrease criteria pollutant emissions from their diesel products. The use of low-emission diesel in on-road vehicles and off-road equipment will reduce tailpipe NOx and PM emissions, in addition to other criteria pollutants. Some studies carried out to date on hydrotreated vegetable oil have reported NOx emission reductions of 6 percent to 25 percent and PM emission reductions of 28 percent to 46 percent, depending on the types of fuels, drive cycles tested, and diesel engines used. This standard is anticipated to both increase consumption of low-emission diesel fuels, and to reduce emissions from conventional fuels. This measure is anticipated to provide NOx benefits predominately from legacy (pre-2010) on-road heavy-duty vehicles, off-road engines, stationary engines, portable engines, marine vessels and locomotives, as well as NOx and diesel PM benefits in potentially all model year off-road

engines, stationary engines, portable engines, marine vessels and locomotives. Interstate vehicles, even those registered out-of-State but operating on CARB diesel blended with low-emission diesel, are also anticipated to provide emission reduction benefits.

Controlling Criteria Emissions from Renewable Fuels

The ***Low Carbon Fuel Standard (LCFS) and Alternative Diesel Fuel (ADF) Regulations*** work together to reduce the carbon intensity of the California fuel supply. The regulations also limit criteria emissions from alternative fuels and/or alternative fuel mix blends (a mix of fuels made from renewable feedstocks, which are then blended with conventional gasoline or diesel). The regulations were amended in 2018 to extend the carbon intensity target of 20 percent to 2030. Due to regulatory constraints, the LCFS and ADF do not apply to fossil jet fuel, aviation gasoline, fuels used in interstate locomotives, or fuels used for the propulsion of ocean-going vessels – regulatory control over these fuels lies at the national and international level.

STEP 2(B): OTHER STATES' AND NONATTAINMENT AREAS' OFF-ROAD CONTROL MEASURES

Table 20 summarizes the most stringent control measures currently in use in any state or nonattainment that have been identified and discussed for off-road equipment. Each of the measures identified in this table are discussed in more detail in this section, below.

Table 20: Comparison of Stringency – Off-Road Measures

CARB Control Programs Compared to Federal Standards and Control Programs in Other States and Nonattainment Areas

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
New Engine Standards			
New Engine Standards: Off-Road Diesel Engine Emission Standards (general)	Tier 4 Off-Road Engine Standards (CARB and U.S. EPA) Future Measure: *Tier 5 Off-Road Vehicles and Equipment measure (CARB)*	California's emission standards for off-road diesel engines are consistent with those of U.S. EPA and the most stringent in the nation. CARB's current emission standards for new off-road engines with a power rating between 175 and 300 hp are set at the same level of stringency as federal standards, and requires Tier 4 emission standards (which use advanced after treatment technologies such as diesel particulate filters and selective catalytic reduction). This regulation is applicable to all diesel-fueled, self-propelled off-road equipment with at least 25 HP. With the Tier 5 Off-Road Vehicles and Equipment Measure, CARB has committed to develop and propose standards and test procedures for new off-road CI engines More stringent PM and NOx standards for engines greater than or equal to 56 kW (75 hp), including the following: • Aftertreatment-based PM standards for engines less than 19 kW (25 hp), • Aftertreatment-based NOx standards for engines greater than or equal to 19 kW (25 hp) and less than 56 kW (75 hp), and • First-time CO2 tailpipe standards targeting a 5 to 8.6 percent reduction. • Other possible elements include enhancing in-use compliance, proposing more representative useful life periods, idle requirements and developing a low load test cycle. It is expected that Tier 5 requirements would rely heavily on technologies manufacturers are developing to meet the recently approved low-NOx standards and enhanced in-use requirements for on-road- heavy-duty engines. *(Note: CARB has committed to pursue the Tier 5 Off-Road Vehicles and Equipment measure, but this measure has not yet been proposed to the Board for approval/adoption)*	No other state has more stringent exhaust emission standards for off-road equipment than California. Currently CARB and U.S. EPA limit exhaust emissions to same "Tier 4" levels: • NOx: 0.3 g/bhp-hr • PM: 0.015 g/bhp-hr
New Engine Standards: Off-Road Zero-Emission Engine Standards (general)	Future Measure: *Off-Road Zero-Emission Targeted Manufacturer Rule measure (CARB)*	The Off-Road Zero-Emission Targeted Manufacturer Rule would accelerate the development and production of zero-emission off-road equipment and powertrains into more sectors (including wheel loaders, excavators, and bulldozers) as technology advancements occur due to existing CARB zero-emission regulations and regulations in the forklifts, cargo handling equipment, off-road fleets, and small off-road engines sectors. For this measure, CARB would propose to develop a regulatory measure that would require manufacturers of off-road equipment and/or engines to produce for sale zero-emission equipment and/or powertrains as a percentage of their annual statewide sales volume to ensure these globally emerging zero-emissions products and related innovations come to California.	No other state requires zero-emission off-road engine standards.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
		(Note: CARB has committed to pursue the Off-Road Zero-Emission Targeted Manufacturer Rule measure, but this measure has not yet been proposed to the Board for approval/adoption)	
In-Use Emission Controls			
In-Use Emissions Controls: Fleet Rules (Off-Road Equipment – General)	In-Use Off-Road Diesel-Fueled Fleets Regulation (Off-Road Regulation) (CARB) Future Measure: *Clean Off-Road Fleet Recognition Program (CARB)*	California's in-use emission controls for off-road equipment are the most stringent in the nation. CARB's off-road regulation controls diesel PM and NOx emissions from >150,000 in-use off-road engines by requiring their owners to retire, replace, or repower older engines, and/or installing verified exhaust retrofit control technologies. Additionally, all vehicles are reported and labeled, and older, dirtier vehicles are restricted from entering fleets. With the 2022 Amendments to the In-Use Off-Road Diesel-Fueled Fleets Regulation, CARB further reduced emissions from the in-use off-road diesel equipment sector by increasing the stringency of the regulation's requirements. These amendments create additional requirements to the currently regulated fleets by targeting the oldest and dirtiest equipment that is allowed to operate indefinitely under the current regulation's structure. The amendments will require fleets to phase-out use of the oldest and highest polluting off-road diesel vehicles in California; prohibit the addition of high-emitting vehicles to a fleet; and require the use of R99 or R100 renewable diesel in off-road diesel vehicles. The amendments phase-in starting in 2024 through the end of 2036 and include changes to enhance enforceability and encourage the adoption of zero-emission technologies. CARB anticipates further emission reductions from the off-road equipment fleets through the Clean Off-Road Fleet Recognition Program measure, which would create a non-monetary incentive to encourage off-road fleets to go above and beyond existing regulatory fleet rule compliance and adopt advanced technology equipment with a strong emphasis on zero-emission technology. This measure would provide a standardized methodology for contracting entities, policymakers, state and local government, and other interested parties to establish guidelines for contracting criteria or require participation in the program to achieve their individual policy goals. *(Note: CARB has committed to develop the Clean Off-Road Fleet Recognition Program measure, but this measure has not yet been proposed to the Board for approval/adoption)*	While Chicago (IL) and New York City (NY) have in-use fleet controls for construction equipment, no other state or nonattainment area controls in-use off-road equipment fleets more stringently than CARB.
Source-Specific Rules			
New Engine Standards: Agricultural equipment	Tier 4 Off-Road Engine Standards (CARB and U.S. EPA)	U.S. EPA and California adopted equivalent Tier 4 standards in 2004 that require additional emission reductions from off-road engines, including those used in mobile agricultural equipment.	No state has more stringent requirements for new emission performance standards for agricultural equipment engines than California.
In-Use Emissions Controls: Agricultural Equipment	Funding Agricultural Replacement Measures for Emission Reductions (FARMER) Program (CARB)	California's in-use emission control program for agricultural equipment is among the most stringent in the nation. CARB's Funding Agricultural Replacement Measures for Emission Reductions (FARMER) Program provides funding through local air districts for agricultural harvesting equipment, heavy-duty trucks, agricultural pump engines, tractors, and other equipment used in agricultural operations. Local air districts receive funds based on a formula and award them to farmers and agricultural businesses for individual projects.	CARB's agricultural equipment fleet controls are among the most stringent in the nation.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
New Engine Standards: Airport Ground Support Equipment (GSE)	Large Spark Ignition (LSI) Fleet Regulation (CARB) Tier 4 Off-Road Engine Standards (CARB and U.S. EPA) Future measure: *Zero-Emission Airport Ground Support Equipment measure (CARB)*	California's emission controls for Airport Ground Support Equipment (GSE) are the most stringent in the nation. NOx limits for the LSI Engine Standard for engines > 1.0 liter (the typical engine size for GSE) is 0.6 g/bhp-hr. Engines meeting this standard are 70 percent cleaner than LSI engines produced as recent as 2009. Additionally, diesel engines in newly manufactured GSE must meet the Tier 4 emission standards applicable to off-road compression ignition engines. CARB is anticipated to further increase the stringency of emission controls with the Zero-Emission Airport Ground Support Equipment measure, which will act as a catalyst to further adoption of zero-emission equipment in the off-road sector, facilitate the transfer of technology to suitable heavier duty-cycle applications, and expand use of zero-emission infrastructure. *(NOTE: CARB has committed to pursue the Zero-Emission Airport Ground Support Equipment measure, but it has not yet been proposed to the Board for approval/adoption.)*	No other state has more stringent exhaust emission standards for airport ground support equipment than California.
In-Use Emissions Controls: Fleet Rules (Airport Ground Support Equipment)	In-Use Off Road Diesel-Fueled Fleets Regulation (CARB) Large Spark-Ignition (LSI) Engine Fleet Requirements Regulation (CARB) Portable Diesel-Engines Air Toxic Control Measure (CARB) Future Measure: *Zero-Emission Airport Ground Support Equipment measure (CARB)*	California's in-use emission controls for airport ground support equipment (GSE) are the most stringent in the nation. The In-Use Off-Road Diesel-Fueled Fleets Regulation requires GSE fleets operating in-use diesel equipment to meet an annual fleet average emissions target that decreases over time. For example, for equipment over 175 and under 750 HP, the final 2023 NOx fleet average target is 1.5 g/bhp hr, which is equivalent to the interim Tier 4 NOx standard for newly produced engines. Fleets that do not meet the required annual fleet average must meet the BACT requirements that require turnover, repower or retrofit of a specific percent of a fleet's total HP. These requirements are currently being phased in. Airport GSE fleets operating LSI GSE must meet the in-use LSI engine fleet requirements. Adopted in 2006, the LSI Engine Fleet Requirements Regulation requires GSE fleets to maintain an average emission level of no more than 2.5 g/bhp hr HC+NOx, starting January 1, 2013. Non-mobile GSE such as portable air-start units, ground power units and air conditioners may be subject to the Portable Diesel-Engines Air Toxic Control Measure (ATCM). CARB is anticipated to further increase the stringency of emission controls with the Zero-Emission Airport Ground Support Equipment measure. *(NOTE: CARB has committed to develop the Zero-Emission Airport Ground Support Equipment measure, but it has not yet been proposed to the Board for approval/adoption.)*	No other state or nonattainment area controls airport GSE more stringently than CARB.
New Engine Standards: Cargo Handling Equipment (CHE)	Cargo Handling Equipment Regulation (CARB) Future Measure: *Cargo Handling Equipment*	California's emission controls for Cargo Handling Equipment (CHE) are the most stringent in the nation. CARB's Cargo Handling Equipment regulation sets performance standards for newly acquired engines, as well as in-use mobile CHE at ports or intermodal rail yards. CARB is anticipated to further increase the stringency of the CHE Regulation by transitioning CHE to zero-emission beginning in 2026. Based on the current state of zero-emission CHE technological developments, the transition to zero-emission would most likely be achieved largely through the electrification of CHE.	No other state has more stringent exhaust emission standards for cargo handling equipment than California.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
	Amendments measure (CARB)	Staff anticipates that all yard trucks and forklifts would be zero-emission by 2030, rubber-tired gantry cranes would be zero-emission by 2032, and 90 percent of other CHE will be zero-emission by 2036. *(Note: CARB has committed to pursue the Cargo Handling Equipment Amendments measure, but this measure has not yet been proposed to the Board for approval/adoption)*	
In-Use Emissions Controls: Fleet Rules (Cargo Handling Equipment)	Cargo Handling Equipment Regulation (CARB) Future measure: *Amendments to the Cargo Handling Equipment measure (CARB)*	California's in-use emission controls for cargo handling equipment (CHE) are the most stringent in the nation. The Cargo Handling Equipment regulation was adopted in 2005 to establish BACT requirements for in-use and newly purchased CHE, and amended in 2011 to include opacity monitoring requirements. The CHE regulation includes performance standards for in-use, mobile CHE at ports or intermodal rail yards in California, and requires that all newly purchased yard truck and non-yard truck equipment brought onto a port or intermodal rail yard must have either a Tier 4 Final off road engine or an on-road engine meeting the 2010 or newer on-road emission standards, and that all legacy in-use non-yard truck engines that are still in service (Tier 0 – Tier 3) must have a Verified Diesel Emission Control Strategy (VDECS) installed. CARB is anticipated to further increase the stringency with the Amendments to the Cargo Handling Equipment Regulation would set in-use requirements for diesel cargo handling equipment at ports and rail yards, including but not limited to: yard trucks (hostlers), rubber-tired gantry cranes, container handlers, and forklifts. Staff would assess the availability and performance of zero-emission technology as an alternative to all combustion-powered cargo equipment. The regulatory amendments would propose an implementation schedule for new equipment with effective dates beginning in 2026. *(Note: CARB has committed to pursue the Amendments to the Cargo Handling Equipment measure, but this measure has not yet been proposed to the Board for approval/adoption)*	No other state or nonattainment area has more stringent in-use fleet requirements for CHE than California.
New Engine Standards: Commercial Harbor Craft (CHC)	Commercial Harbor Craft Regulation (CARB)	California's emission controls for commercial harbor craft (CHC) are the most stringent in the nation. CARB's 2008 and 2011 CHC Regulations reduced NOx and diesel PM emissions from crew and supply boats, ferries, excursion vessels, towboats, push boats, tug boats, barges and dredges. CARB amended the CHC regulation in 2022, establishing expanded and more stringent in-use requirements to cover more vessel categories, including all tank barges, pilot vessels, research vessels, workboats, commercial passenger fishing, and commercial fishing vessels. The amendments also mandate accelerated deployment of zero-emission and advanced technologies in vessel categories where technological feasibility has been demonstrated.	No other state has more stringent exhaust emission standards for commercial harbor craft than California.
In-Use Emissions Controls: Fleet Rules (Commercial Harbor Craft)	Commercial Harbor Craft Regulation (CARB)	California's in-use emission controls for commercial harbor craft (CHC) are the most stringent in the nation. The Commercial Harbor Craft regulation (adopted in 2008 and amended in 2010) included in-use limits that required diesel PM and NOx emission controls on ferries, excursion vessels, and tugboats, towboats, and push boats. The 2011 amendments extended the types of CHC for which in-use engine requirements apply to include crew and supply, barges and dredges. CARB amended the CHC regulation in 2022, establishing expanded and more stringent in-use requirements to cover more vessel categories including all tank barges, pilot vessels, research vessels, workboats, commercial passenger fishing, and commercial fishing vessels. The amendments also mandate accelerated deployment of zero-emission and advanced technologies in vessel categories where technology feasibility has been demonstrated.	No other state or nonattainment area controls in-use CHC emissions more stringently than CARB.

CARB Control Program MSM Analysis
for the SCAQMD 2024 12 µg/m^3 annual PM2.5 Plan

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
New Engine Standards: Forklifts	Tier 4 Off-Road Engine Standards (CARB and U.S. EPA) Future Measures: *Zero-Emission Off-Road Forklift Regulation Phase 1 measure (CARB)* *Off-Road Zero-Emission Targeted Manufacturer Rule measure (CARB)*	California's emission controls for forklifts are the most stringent in the nation. Forklifts powered by LSI engines (gasoline and natural gas) are subject to new engine standards that include both criteria pollutant and durability requirements since 2001, with the cleanest requirements phased-in starting in 2010. Diesel Forklifts > 25 HP are subject to Tier 4 Final emission standards (based on the use of advanced after-treatment technologies such as diesel particulate filters and selective catalytic reduction) starting in 2013. CARB is anticipated to further increase the stringency of emission controls with the Zero-Emission Off-Road Forklift Regulation Phase I measure, which would be designed to accelerate the deployment of zero-emission forklift technologies. The regulatory amendments would propose requirements that prohibit the new purchases of LSI forklifts, with an implementation schedule beginning in 2026. *(NOTE: CARB has committed to pursue the Zero-Emission Off-Road Forklift Regulation Phase 1 measure, but it has not yet been proposed to the Board for approval/adoption.)* CARB is anticipated to further increase the stringency of in-use emission controls for forklifts through the Off-Road Zero-Emission Targeted Manufacturer Rule measure. *(NOTE: CARB has committed to pursue the Off-Road Zero-Emission Targeted Manufacturer Rule measure, but it has not yet been proposed to the Board for approval/adoption.)*	No state has more stringent requirements for new emission performance standards for forklifts engines than California.
In-Use Emissions Controls: Fleet Rules (Forklifts)	Off-road Diesel Regulation (CARB) LSI Fleet Regulation (CARB) 2022 Amendments to the In-Use Off-Road Diesel Fueled Fleets Regulation (CARB) Future Measure: *Zero-Emission Off-Road Forklift Regulation Phase 1 (CARB)* Future Measure: *Amendments to the Cargo Handling Equipment measure (CARB)*	California's in-use emission controls for forklifts are the most stringent in the nation. Forklift fleets subject to both the LSI fleet regulation (if powered by gasoline or propane), and the off-road diesel fleet regulation (if powered by diesel) are required to retire, repower, or replace higher-emitting equipment in order to maintain fleet average standards. Diesel Forklifts > 25 HP are subject to fleet average emission requirements under the Off-Road Diesel Regulation starting in 2010. Under the 2022 Amendments to the In-Use Off-Road Diesel Fueled Fleets Regulation, forklifts are also subject to requirements begin to transition fleets from the oldest and highest-emitting off-road engines in operation in California by phasing out Tier 0 – Tier 2 equipment beginning in 2024. Also beginning in 2024, the regulation includes requirements to restrict the addition of new vehicles and/or engines with Tier 3 and 4i engines. CARB is anticipated to further increase the stringency of in-use emission controls with the Zero-Emission Off-Road Forklift Regulation Phase I measure, which would be designed to accelerate the deployment of zero-emission forklift technologies. The regulatory amendments would propose requirements for fleets to retire existing LSI forklifts that are 13 years and older, and would propose an implementation schedule beginning in 2026. *(NOTE: CARB has committed to develop the Zero-Emission Off-Road Forklift Regulation Phase 1 measure, but it has not yet been proposed to the Board for approval/adoption.)* CARB is also anticipated to further reduce the emissions from forklifts operating at ports and intermodal rail yards through the Amendments to the Cargo Handling Equipment Regulation measure. Under the CHE measure, forklifts would begin transitioning to zero-emission technologies. Staff anticipates that all forklifts operating at ports and intermodal rail yards would be zero-emission by 2030. *(NOTE: CARB committed to pursue the Amendments to the Cargo Handling Equipment measure, but this measure has yet to be proposed to the Board for approval/adoption.)*	No other state or nonattainment area has more stringent fleet requirements for in-use forklifts than CARB.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
New Engine Standards: Marine Engines	Exhaust Emission Regulations for Spark-Ignition Marine Engines (CARB) Tier II Emission Standards for Inboard and Stern-Drive Marine Engines (CARB) Evaporative Emission Control Standards (CARB) Future Measure: *Spark-Ignition Marine Engine Standards measure (CARB)*	CARB's recreational boats and marine engine program exceeds the stringency of U.S. EPA's federal standards and are the most stringent in the nation: • The Exhaust Emission Regulations for Spark-Ignition Marine Engines (1998) controls emissions at the same level of stringency as national regulations; • The Tier II Emission Standards for Inboard and Stern-Drive Marine Engines (2001) controls emissions at the same level of stringency as national regulations; and • The Evaporative Emission Control Standards (2015) exceeds the stringency of applicable national regulations set by U.S. EPA in 2008 for gasoline-fueled spark-ignition marine watercraft >30 kilowatts. The Spark-Ignition Marine Engine Standards measure would reduce emissions from new spark-ignition (SI) marine engines by adopting more stringent exhaust standards for outboard and personal watercraft, which currently do not use catalyst control technologies. Staff estimates that stricter standards could reduce combined HC or ROG and NOx emissions by approximately 70 percent below the current HC+NOx standard (≈16.5 grams per kilowatt-hour (g/kW-hr)) for engines greater than or equal to 40 kilowatts (kW) in power, and by approximately 40 percent for engines less than 40 kW in power. CARB staff is also evaluating whether some outboard and personal watercraft vessels could be propelled by zero-emission technologies in certain applications. For example, zero-emission powertrains have the potential to gradually replace most outboard engines less than 19 kW, as well as many new personal watercraft engines. *(Note: CARB has committed to pursue the Spark-Ignition Marine Engine Standards measure, but this measure has not yet been proposed to the Board for approval/adoption)*	No other state has the authority to set exhaust emission and/or evaporative emission standards that exceed the stringency of U.S. EPA's national standards.
New Engine Standards: Off-Highway Recreational Vehicles (OHRVs)	Exhaust Emission Standards for OHRVs (CARB) Evaporative Emission Standards for OHRVs (CARB)	California's emission controls for Off-Highway Recreational Vehicles (OHRVs) are the most stringent in the nation. CARB's exhaust emission standards control emissions from off-highway motorcycles, all-terrain vehicles, and utility terrain vehicles at more stringent levels than applicable national standards set by U.S. EPA for MY 2022 – 2027+. CARB evaporative emission standards harmonize with federal limits for MY 2020 – 2026. California's evaporative emission standards will exceed the stringency of federal requirements for MY 2027+.	No other state has the authority to set exhaust emission and/or evaporative emission standards that exceed the stringency of U.S. EPA's national standards.
In-Use Emissions Controls: Fleet Rules (Off-Highway Recreational Vehicles)	OHRV "Red Sticker" program (CARB)	California's in-use emission controls for Off-Highway Recreational Vehicles (OHRVs) are the most stringent in the nation. CARB's "Red Sticker" program requires in-use OHRVs that do not meet the applicable exhaust emission standards display a red registration sticker that limits operation at certain off highway recreational vehicle parks located in nonattainment areas during peak ozone season.	No other state or nonattainment area controls in-use emissions from OHRV more stringently than CARB.
New Engine Standards: Small Off-Road Engines (SORE)	Exhaust and Evaporative Standards for Small Off-Road Engines (CARB)	California's emission controls for small off-road engines (SORE) are the most stringent in the nation. CARB's current SORE program (through MY 2023) aligns the exhaust and evaporative standards for SORE with federal standards, and sets requirements for Zero-Emission SORE equipment. CARB further increased the stringency of emission controls with the 2021 Amendments to the SORE Regulations, which will accelerate the deployment of zero-emission technologies, set tighter exhaust and evaporative emission standards (MY 2024+), and enhance enforcement of current emission standards for SORE. Beginning in MY 2024, exhaust and evaporative emission standards were lowered to zero, except	No other state has the authority to set exhaust emission and/or evaporative emission standards that exceed the stringency of U.S. EPA's national standards.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
		for pressure washers with engine displacement greater than or equal to 225 cubic centimeters and generators (phase-in for ZE pressure washers and generators begins in MY 2028 and 2024, respectively). For MY 2024 and subsequent years, CARB's emission control requirements for SORE will exceed federal requirements.	
New Engine Standards: Transport Refrigeration Units (TRU)	Airborne Toxic Control Measure for In-Use Diesel-Fueled TRUs and TRU Generator Sets (TRU ATCM) (CARB) Future Measure: *Transport Refrigeration Units (TRU) Regulation Part 2 measure (CARB)*	California's emission controls for Transport Refrigeration Units (TRU) are the most stringent in the nation. CARB adopted the Airborne Toxic Control Measure (ATCM) for In-Use Diesel-Fueled TRUs and TRU Generator Sets, and Facilities Where TRUs Operate (TRU ATCM) in 2004 and amended it in 2010 and 2011 to reduce diesel particulate matter (PM) emissions and resulting health risk from diesel-powered TRUs used to control the environment of temperature-sensitive products. In 2022, CARB further amended the TRU ATCM (2022 Amendments), which included requirements that MY 2023 and newer trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines shall meet a PM emission standard of 0.02 grams per brake horsepower-hour or lower (aligns with the United States Environmental Protection Agency Tier 4 final off-road PM emission standard for 25-50 horsepower engines). CARB is anticipated to further increase the stringency of in-use emission controls on TRUs via the Transport Refrigeration Units Regulation Part 2 measure, which would be designed to require zero-emission trailer TRUs, domestic shipping container TRUs, railcar TRUs, and TRU generator sets. *(Note: CARB has committed to pursue the Transport Refrigeration Unit Regulation Part 2 measure, but this measure has not yet been proposed to the Board for approval/adoption)*	No other state or nonattainment area requires as stringent of emission standards for TRUs
In-Use Emission Controls (Fleet Standard): Transport Refrigeration Units (TRU)	Air Toxic Control Measure for Transport Refrigeration Units and TRU Generator Sets (CARB) Future measure: *Transport Refrigeration Units (TRU) Regulation Part 2 measure (CARB)*	California's in-use emission controls for Transport Refrigeration Units (TRUs) are the most stringent in the nation. CARB adopted the Airborne Toxic Control Measure (ATCM) for In-Use Diesel-Fueled TRUs and TRU Generator Sets, and Facilities Where TRUs Operate (TRU ATCM) in 2004 and amended it in 2010 and 2011 to reduce diesel particulate matter (PM) emissions and resulting health risk from diesel-powered TRUs used to control the environment of temperature-sensitive products. In 2022, CARB further amended the TRU ATCM (2022 Amendments), which included Zero-emission truck TRU fleet requirements. Beginning December 31, 2023, TRU owners shall turnover at least 15 percent of their truck TRU fleet (defined as truck TRUs operating in California) to ZE technology each year (for seven years). All truck TRUs operating in California shall be ZE by December 31, 2029. CARB is anticipated to further increase the stringency of in-use emission controls on TRUs via the TRU Regulation Part 2 measure, which would be designed to require zero-emission trailer TRUs, domestic shipping container TRUs, railcar TRUs, and TRU generator sets. *(Note: CARB has committed to pursue the Transport Refrigeration Unit Regulation Part 2 measure, but this measure has not yet been proposed to the Board for approval/adoption)*	No other state or nonattainment area controls in-use emissions from TRUs more stringently than CARB.
Primarily Federally and Internationally Regulated Sources			
New Engine Standards: Locomotives	Tier 4 NOx and PM Locomotive emission standards (U.S. EPA) CARB has petitioned U.S. EPA to further increase stringency.	U.S. EPA has the sole authority to establish emissions standards for locomotives. CARB petitioned U.S. EPA in 2017 to increase stringency by developing Tier 5 national emission standards for newly manufactured locomotives, and more stringent national requirements for remanufactured locomotives (by ~2020) *(NOTE: CARB has petitioned U.S. EPA for more stringent locomotive standards given the needs in California's nonattainment areas, but approval/adoption of this MSM rests exclusively with U.S. EPA and is thus beyond the purview of CA.)*	No state has emission standards for locomotives that differ from U.S. EPA's.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
	(2016 State SIP Strategy's More Stringent National Locomotive Emission Standards measure)		
In-Use Emission Controls (Locomotives): In-Use Locomotive Regulation	1998 Locomotive NOx Fleet Average Emissions Agreement in the South Coast Air Basin Statewide Rail Yard Agreement for California Rail Yards (Locomotive Memorandum of Understanding) (CARB) In-Use Locomotive Regulation (CARB)	California's in-use emission reduction measures for locomotives are the most stringent in the nation. The 1998 Locomotive NOx Fleet Average Emissions Agreement in the South Coast Air Basin (1998 MOU), signed by CARB, Union Pacific Railroad and BNSF Railway, accelerated the introduction of cleaner locomotives into the South Coast Air Basin. Under the MOU, UP and BNSF agreed to operate locomotive fleets that meet an average Tier 2 NOx emission standard, beginning in 2010 and running through 2030. The 2005 Statewide Rail Yard Agreement for California Rail Yards, a Memorandum of Understanding (MOU) with the Class I Railroads to increase the use of idle control devices, lowered locomotive idle times to 15 minutes, and opened a collaboration to produce Health Risk Assessments on 18 major railyards in the State, which was completed in 2015. Adopted in April 2023, the In-Use Locomotive Regulation accelerates the adoption of advanced, cleaner technologies for locomotive operations, including zero-emission technologies. The regulatory elements include: • Starting in 2024: Spending Account Locomotive operators would be required to fund their own trust account based on the emissions created by their locomotive operations in California. The dirtier the locomotive, the more funds must be set aside. Spending Account funds would be used to fund turnover to cleaner locomotives, rail equipment, and/or related infrastructure. • Starting in 2030: In-Use Operational Requirements Only locomotives less than 23 years old would be able to be used in California. Switchers industrial and passenger locomotives with original engine build dates of 2030 or newer would be required to operate in a ZE configuration in California. Freight line haul locomotives with original engine build dates of 2035 and newer would be required to operate in a ZE configuration in California. • Starting in 2024: Idling Limit All locomotives with automatic shutoff devices (AESS) would not be permitted to idle longer than 30 minutes, unless for an exempt reason. Exemptions closely align with those described by U.S. EPA, and would be granted for reasons like maintaining air brake pressure or to perform maintenance. • Starting in 2024: Registration and Reporting Locomotives operating in the State would be required to register with CARB. Reporting includes and annual administrative payment. Locomotive activity, emission levels and idling data would be required to be reported annually. Local air districts may also pursue indirect source rules for freight facilities that could result in reductions from this category.	No other state has a regulation to accelerate the adoption of advanced, cleaner locomotive operations technologies, including zero-emission.
New Engine Standards: Ocean-Going Vessels	Tier III emission standards (IMO) Future Measure:	The International Maritime Organization (IMO) has the sole authority to establish emissions standards for ocean-going vessels. The IMO regulates NOx emissions from OGVs, but does not limit PM exhaust emissions.	No state has emission standards for ocean-going vessels that differ from the IMO's standards.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
	Future Measures for Ocean-Going Vessel Emission Reductions measure (CARB)	In the 2022 State SIP Strategy, CARB also committed to a future measure to further reduce in-use emissions from OGVs with the Future Measures for Ocean-Going Vessel Emission Reductions measure. Due to the IMO's authority on setting emission standards, for this measure, CARB would strongly advocate for stricter emission regulations and highlight the need to reduce pollution to protect public health *(Note: CARB has committed to pursue the Future Measures for Ocean-Going Vessel Emission Reductions measure, but this measure has not yet been proposed to the Board for approval/adoption)*	
In-Use Emission Controls: Ocean-Going Vessels	Ocean-Going Vessel Fuel Regulation (CARB) At-Berth Regulation (CARB) Future Measure: *Future Measures for Ocean-Going Vessel Emission Reductions measure (CARB)*	California's in-use emission reduction measures for ocean-going vessels are the most stringent in the nation. CARB's 2008 Ocean Going Vessel (OGV) Fuel Regulation reduces PM, NOx, and SOx emissions from OGVs by requiring operators of OGVs to use less polluting marine distillate fuels instead of heavy fuel oil in their diesel engines and auxiliary boilers while operating within approximately 24 nautical miles (nm) of the California coastline (otherwise known as Regulated California Waters, or RCW). Under Annex VI, the IMO sets fuel sulfur limits. The fuel sulfur limit in the North American Emission Control Areas (ECAs) is 0.1 percent sulfur within 200 nm, the same percent sulfur (as CARB's Ocean-Going Vessel OGV Fuel Regulation. However, there are some differences between the regulations. The California regulation specifies the use of cleaner "distillate" grades of fuel, rather than just a sulfur limit, and the federal ECA provides exemptions for many vessels that are not exempted by CARB's OGV Fuel Regulation (E.g. scrubbers, ultra-low sulfur fuel oil). California is the only state that further regulates the sulfur content and type of fuels that can be used in OGVs, above what the IMO requires. CARB's OGV At-Berth Regulation (At-Berth Regulation), which was amended in 2020, reduces emissions from vessels docked at California ports by requiring that vessels turn off their auxiliary diesel engines and plug in to shore-based grid electrical power, or utilize alternative technologies to achieve comparable emission reductions. Although California is the only state in the United States that has a regulation requiring vessels to control emissions at berth, other states around the country have installed and are using shore power to control OGV emissions at berth. Seattle, New York, and New Jersey provide shore side power for cruise vessels. In addition, the Port of Tacoma has provided shore power to container ships since 2010 and is adding shore power to be ready for use by the end of 2023. The Port of Miami has plans to install five shore power systems for cruise ships by the end of the year, which when finished, will be the largest shore power system in the world. In the 2022 State SIP Strategy, CARB also committed to a future measure to further reduce in-use emissions from OGVs with the Future Measures for Ocean-Going Vessel Emission Reductions measure. Under this measure, CARB will consider available control options through the use of operational changes and new technologies currently in development, including advances in exhaust capture and control, mobile shore power connections, cleaner fuels (such as LNG, hydrogen, methanol, ammonia, etc.), alternative power sources (including batteries and fuel cells), as well as potential vessel side technologies (such as water-in-fuel emulsion). Incentives or regulatory measures may be pursued to achieve emissions reductions from using cleaner engines or cleaner fuels, reducing emissions while anchored within RCW, sailing at slower speeds while in RCW (Vessel Speed Reduction, aka VSR), and requiring bulk/general cargo vessels to reduce emissions at berth.	California is the only state that further regulates the sulfur content and type of fuels that can be used in OGVs, above what the IMO requires. California is the only state in the United States that has a regulation requiring vessels to control emissions at-berth. There are no other states outside of California that regulate shipping emissions

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
		Certain areas and ports within California currently use incentive programs to support OGV emissions reductions through VSR and other mechanisms, The Port of Long Beach has employed a Green Ship Incentive Program since 2012 which is a voluntary program that incentivizes cleaner vessel visits, with incentives ranging from $600 to $6,000 depending on the vessel's Environmental Ship Index (ESI) score. The Port of Los Angeles also participates in the ESI Program, and provides incentives for Tier III vessels to come into port (incentive grant of $5,000 per call), and offers a Technology Advancement Program grant ($750 per call) for OGVs that demonstrate an emission reduction technology that reduces diesel particulate matter and NOx emissions. While there are no other states outside of California that regulate shipping emissions, other ports in the United States also incentivize ships to use cleaner technology and practices that reduce emissions beyond the regulatory requirements set by the IMO. The Ports of New York and New Jersey's Clean Vessel Incentive Program offers financial incentives to encourage OGVs to voluntarily enhance their engines, fuel, and technology. The program employs a scoring system that rewards VSR and the vessel's Environmental Ship Index (ESI) score, with additional points given to vessels meeting clean engine standards. *(Note: CARB has committed to pursue the Future Measures for Ocean-Going Vessel Emission Reductions measure, but this measure has not yet been proposed to the Board for approval/adoption)*	
In-Use Emission Controls (Aircraft): Future Measures for Aviation Emission Reductions	Future Measure: *Future Measures for Aviation Emission Reductions (CARB)*	Future Measures for Aviation Emissions Reductions would reduce emissions from airport and aircraft related activities, including main aircraft engines, auxiliary power units (APU), and airport ground transportation. Due to U.S. EPA's authority on setting emission standards, for this measure, CARB would strongly advocate for stricter emission regulations and highlight the need to reduce pollution to protect public health. CARB would also explore requiring all larger airports to perform a comprehensive and standardized emission inventory. An accurate emission inventory that reflects all on-ground and near-ground emissions would establish a baseline and enable verifiable and quantifiable future emissions reductions. CARB would continue to assess technology development for the aviation sector. The purpose is to help inform and support CARB planning, regulatory, and voluntary incentive efforts. Concurrently, CARB would support, track, and explore current, in-development, and future emission reduction technology advancements. CARB would evaluate federal, State, and local authority in setting operational efficiency practices to achieve emissions reductions. Operational practices include landing, takeoff, taxi, and running the APU, and contribute to on-ground and near-ground emissions. CARB would similarly work with U.S. EPA, air districts, airports, and industry stakeholders in a collaborative effort to develop regulations, voluntary measures and incentive programs. *(Note: CARB has committed to pursue the Future Measures for Aviation Emission Reductions, but this measure has not yet been proposed to the Board for approval/adoption)*	No state has emission standards for aircraft that differ from U.S. EPA's and FAA's.
Fuels			
Fuels Standards: Diesel Standards	CARB Diesel Fuel Regulations and Ultra Low Sulfur Diesel (CARB) Future measure:	California's fuel standards for diesel are the most stringent in the nation. CARB Diesel Fuel Regulations include stringent requirements for fuel mixture specifications for aromatic hydrocarbons and sulfur, and have establish a lubricity standard and applies to sales of fuel used in on-road vehicles and off-road vehicles and locomotives in California. CARB's ULSD program reduces NOx and PM emissions significantly relative to U.S. EPA requirements, providing approximately 7 percent more NOx reductions and 25 percent more PM reductions than federal diesel.	No state requires cleaner burning diesel than California. The California diesel fuel regulations exceed federal requirements in stringency.

CARB Control Program MSM Analysis
for the SCAQMD 2024 12 µg/m^3 annual PM2.5 Plan

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
	Low Emission Diesel measure (CARB)	CARB is anticipated to further increase the stringency of controls on criteria pollutant emissions diesel products. *(NOTE: CARB has committed to pursue the Low Emission Diesel measure, but it has not yet been proposed to the Board for approval/adoption.)*	CARB staff are aware of only one other state, Texas, who has a boutique diesel fuel program that is approved into the SIP. An independent analysis of The Texas Low Emission Diesel program (TxLED) showed that the TxLED fuel emissions performance does not provide as significant of emission reduction benefits as the California specifications.
Fuels Standards: Alternative Fuel Standards (Diesel substitutes)	Low Carbon Fuel Standard (LCFS) (CARB) Alternative Diesel Fuel Regulation (ADF) (CARB)	California's fuel standards for diesel substitutes are the most stringent in the nation. The LCFS and ADF regulations work together to reduce the carbon intensity of the California fuel supply while requiring limits on criteria emissions from alternative fuels and/or alternative fuel mix blends. The LCFS regulation supports alternative fuels used in several off-road applications. However, the program does not apply to fossil jet fuel, aviation gasoline, fuels used in interstate locomotives or fuels used for propulsion of ocean-going vessels.	No other state has set criteria emission requirements on alternative fuels and alternative fuel blends. The Federal Renewable Fuel Standard (RFS II) does not specify criteria requirements for alternative fuels. Other states with low carbon fuel and/or clean fuel programs: • Oregon, Washington, and British Columbia have low carbon fuel standard programs, California participates in the Pacific Coast Collaborative with these states/provinces. • Other states that are considering a clean fuel regulation include: NY, MI, MN, NM, VT, IL, MA.

EMISSION STANDARDS FOR NEW ENGINES AND EQUIPMENT

Off-Road Equipment (General)

CARB ***Tier 4 Off-Road Equipment Standards are*** nearly identical to those finalized by U.S. EPA in its Clean Air Nonroad Diesel Rule. These regulations require engine manufacturers to meet aftertreatment-based exhaust standards for PM and NOx starting in 2011 that are over 90 percent lower than the previous engine generation's emission levels. CARB's new engine standards for off-road equipment is thus aligned with most stringent control program of any in the nation.

Due to constraints in the Act, California is the only state that can set new engine standards (including control measures such as emission standards, sales mandates, warranty provisions, and OBD requirements) that are more stringent than U.S. EPA's national standards. Other states can adopt California programs for which U.S. EPA has provided California with authorizations. While the Act allows other states to adopt CARB's regulations for off-road engine or off-road vehicles (provided that such standards are identical to the CARB standards for which an authorization has been obtained), other states have not yet adopted off-road engine emission standards equivalent to the California off-road regulation, although there are some states currently considering doing so.

CARB has also committed to increase the stringency of off-road equipment emission standards with the ***Tier 5 Off-Road Vehicles and Equipment measure*** and the ***Off-Road Zero-Emission Targeted Manufacturer Rule measure****.* Under the Tier 5 Off-Road Vehicles and Equipment measure, CARB would develop and propose standards and test procedures for new off-road CI engines More stringent PM and NOx standards for engines greater than or equal to 56 kW (75 hp). The Off-Road Zero-Emission Targeted Manufacturer Rule would accelerate the development and production of zero-emission off-road equipment and powertrains into more sectors.

IN-USE EMISSION CONTROLS FOR OFF-ROAD ENGINES AND EQUIPMENT

Fleet Rules: Off-Road Equipment (General)

In aggregate, CARB's fleet requirements for off-road equipment are the most stringent in the nation. CARB's ***Cleaner In-Use Off-Road Equipment Regulation (Off-Road Regulation)*** controls diesel PM and NOx emissions from >150,000 in-use offroad engines by requiring their owners to retire, replace, or repower older engines, and/or installing verified exhaust retrofit control technologies to BACT-equivalent engines. Additionally, all vehicles are reported and labeled, and older, dirtier vehicles are restricted from entering fleets.

CARB's Off-Road Regulation controls emissions from aerial lifts, aircraft tugs, backhoes, baggage tugs, belt loaders, cargo loaders, crawler tractors (such as bulldozers), excavators, forklifts, graders, loaders, mowers, rollers, rough terrain forklifts, rubber tired loaders, scrapers, skid steer loaders, snow blowers, tractors,

trenchers, as well as several types of on-road vehicles, such as two-engine vehicles, and workover rigs. Furthermore, CARB has also committed to further emission reductions from the off-road equipment fleets through the ***Clean Off-Road Fleet Recognition Program*** measure, which would create a non-monetary incentive to encourage off-road fleets to go above and beyond existing regulatory fleet rule compliance and adopt advanced technology equipment with a strong emphasis on zero-emission technology.

Some nonattainment areas have fleet requirements that also require BACT-equivalent levels of controls for some off-road equipment (i.e. construction equipment), which are described below.

- New York City's Local Law 77 requires use of ultra-low sulfur diesel fuel and BACT for reducing emissions from non-road equipment above 37 kW used on city construction projects.
- Chicago (IL) Clean Diesel Construction Ordinance bans high-polluting diesel equipment from City construction sites. While the California program requires fleets to turnover to Tier 4 or equivalent control levels, the Chicago ordinance only requires fleets to turnover to Tier 2 or equivalent control levels (on-road vehicles MY 1998 and earlier and pre-US Environmental Protection Agency Tier 1 equipment will be banned under the Chicago ordinance.)

No other state or nonattainment area controls in-use off-road equipment fleets more stringently than CARB. Neither of the New York or Chicago programs cover the full suite of off-road equipment engine types and applications that are regulated under CARB's program. Additionally, they do not have as stringent of labeling and reporting requirements as CARB. Finally, the use of ULSD in off-road equipment in New York provides significantly less emission reductions than the use of ULSD inside of California (as is required – see fuels section for more information), as federal USLD specifications allow significantly less stringent caps on sulfur and aromatic hydrocarbon content in fuels than CARB diesel specifications.

OFF-ROAD ENGINES AND EQUIPMENT: SOURCE-SPECIFIC RULES

Beyond the regulations that apply to the majority of the off-road category, CARB also controls sub-categories of off-road equipment through source-specific emission standards and fleet requirements, as described below.

Agricultural Equipment

Emission Standards for Agricultural Equipment

CARB's new engine standards for off-road agricultural equipment (ag equipment) is consistent with the most stringent of any in the nation. In 2004, U.S. EPA and California adopted equivalent ***Tier 4 Off-Road Engine Emission Standards***, which includes requirements for agricultural equipment engines. Beyond the Off-Road Regulation, CARB also controls sub-categories of off-road equipment through specific fleet requirements, as described below.

In-Use Controls: Agricultural Equipment

CARB's agricultural equipment fleet controls are among the most stringent in the nation. The Funding Agricultural Replacement Measures for Emission Reductions (FARMER) Program provides funding through local air districts for agricultural harvesting equipment, heavy-duty trucks, agricultural pump engines, tractors, and other equipment used in agricultural operations. Local air districts receive funds based on a formula and award them to farmers and agricultural businesses for individual projects. Funding is supported in part by California Climate Investments, a statewide program that puts billions of Cap-and-Trade dollars to work. In April 2022, CARB expanded the project categories within the FARMER Program to include zero-emission agricultural equipment. As of September 2022, $685 million has been allocated, with $347.6 million implemented across 8,057 projects. The emission reductions benefits associated with these projects include 22,400 tons of NO_x reductions, and 1,350 tons of PM 2.5 reductions, Statewide.

Airport Ground Support Equipment (GSE)

Emission Standards for Airport GSE

CARB's new engine standards for airport GSE is the most stringent in the nation. New airport GSE is subject to emission standards under CARB's ***Large Spark Ignition (LSI) Fleet Regulation*** (natural gas and gasoline engines), and under CARB's ***Tier 4 Off-Road Engine Standards*** (diesel engines). NOx limits for the LSI Engine Standard for engines > 1.0 liter (the typical engine size for GSE) is 0.6 g/bhp-hr. Engines meeting this standard are 70 percent cleaner than LSI engines produced as recent as 2009. Additionally, diesel engines in newly manufactured GSE must meet the Tier 4 emission standards applicable to off-road compression ignition engines. Non-mobile GSE such as portable air-start units, ground power units and air conditioners may be subject to the ***Portable Diesel-Engines Air Toxic Control Measure (ATCM)***. The ATCM reduces PM emissions by requiring engine replacement in a schedule based on a fleet's weighted PM emission average. No other state has more stringent exhaust emission standards for airport GSE than CARB. Furthermore, CARB is anticipated to further increase the stringency of emission controls under the ***Zero-Emission Airport Ground Support Equipment measure*** committed to in the 2016 State SIP Strategy.

In-Use Controls: Airport GSE

CARB's new engine standards for airport GSE is the most stringent in the nation. New airport GSE is subject to emission standards under CARB's ***Large Spark Ignition (LSI) Fleet Regulation*** (natural gas and gasoline engines), and under CARB's ***Tier 4 Off-Road Engine Standards*** (diesel engines). NOx limits for the LSI Engine Standard for engines > 1.0 liter (the typical engine size for GSE) is 0.6 g/bhp-hr. Engines meeting this standard are 70 percent cleaner than LSI engines produced as recent as 2009. Additionally, diesel engines in newly manufactured GSE must meet the Tier 4 emission standards applicable to off-road compression ignition engines. Non-mobile GSE such as portable air-start units, ground power units and air conditioners may be subject to the ***Portable Diesel-Engines Air Toxic Control Measure (ATCM)***. The ATCM reduces PM emissions by requiring engine replacement in a schedule based on a fleet's

weighted PM emission average. No other state has more stringent exhaust emission standards for airport GSE than CARB. Furthermore, CARB is anticipated to further increase the stringency of emission controls under the ***Zero-Emission Airport Ground Support Equipment measure*** committed to in the 2016 State SIP Strategy.

CARB's airport GSE fleet requirements are the most stringent in the nation. CARB's ***In-Use Off-Road Diesel-Fueled Fleets Regulation*** requires fleets operating in-use diesel equipment to meet an annual fleet average emissions target that decreases over time to become equivalent to the interim Tier 4 NOx standard for newly produced engines. Airport GSE fleets operating Large Spark-Ignition (LSI) GSE must meet the in-use LSI engine fleet requirements. Adopted in 2006, ***the LSI Engine Fleet Requirements Regulation*** requires GSE fleets to maintain an average emission level of no more than 2.5 g/bhp hr HC+NOx, starting January 1, 2013. Non-mobile GSE such as portable air-start units, ground power units and air conditioners may be subject to the ***Portable Diesel-Engines Air Toxic Control Measure (ATCM)***. The ATCM reduces PM emissions by requiring engine replacement in a schedule based on a fleet's weighted PM emission average. CARB is anticipated to further increase the stringency of emission controls with ***the Zero-Emission Airport Ground Support Equipment measure***. No other state or nonattainment area controls airport GSE more stringently than CARB.

Cargo Handling Equipment (CHE)

Emission Standards for CHE

CARB's ***Cargo Handling Regulation*** established engine performance standards for new CHE used to transfer goods or perform maintenance and repair activities and includes equipment such as yard trucks (hostlers), rubber-tired gantry cranes, top handlers, side handlers, forklifts, and loaders at ports and intermodal rail yards. CARB CHE emission standards are the most stringent of any in the nation, with further increases in stringency anticipated through the ***Cargo Handling Equipment Amendments measure*** committed to in the 2022 State SIP Strategy, which will transition CHE to zero-emission equipment. CARB obtained U.S. EPA authorization in 2012. No other state or nonattainment area has more stringent exhaust emission standards for CHE than California.

In-Use Controls: CHE

CARB's ***Cargo Handling Equipment Regulation*** includes in-use limits that require diesel PM and NOx emission controls for mobile CHE at ports or intermodal rail yards. The CHE Regulation requires that all newly purchased yard truck and non-yard truck equipment brought onto a port or intermodal rail yard must have either a Tier 4 Final off road engine or an on-road engine meeting the 2010 or newer on-road emission standards, and that all legacy in-use non-yard truck engines that are still in service (Tier 0 – Tier 3) must have a Verified Diesel Emission Control Strategy (VDECS) installed. CARB is anticipated to further increase the stringency with ***the Amendments to the Cargo Handling Equipment Regulation***, which would set in-use requirements for diesel cargo handling equipment at ports and rail yards. No other state or

nonattainment area has more stringent in-use fleet requirements for CHE than California.

Commercial Harbor Craft (CHC)

Emission Standards for CHC

CARB's new engine standards for CHC is the most stringent of any in the nation. The ***Commercial Harbor Craft Regulation*** controls NOx and PM emissions from crew and supply boats, ferries / excursion vessels, towboats, push boats, tugboats, barges, and dredges. CARB amended the CHC regulation in 2022, establishing expanded and more stringent in-use requirements to cover more vessel categories, and to accelerate the deployment of zero-emission and advanced technologies in vessel categories where technological feasibility has been demonstrated. No other state has more stringent exhaust emission standards for commercial harbor craft than California.

In-Use Controls: CHC

CARB's ***Commercial Harbor Craft Regulation*** (adopted in 2007) includes in-use limits that require diesel PM and NOx emission controls, which was amended in 2010 and 2022 to extend the types of CHC for which in-use engine requirements apply. The regulation includes in-use limits that required diesel PM and NOx emission controls on ferries, excursion vessels, tugboats, towboats, push boats, crew and supply boats, barges, dredges, tank barges, pilot vessels, research vessels, workboats, commercial passenger fishing, and commercial fishing vessels. The 2022 amendments also mandate accelerated deployment of zero-emission and advanced technologies in vessel categories where technology feasibility has been demonstrated. No other state or nonattainment area controls in-use CHC emissions more stringently than CARB.

Forklifts

Emission Standards for Forklifts

CARB's new engine standards for forklifts are the most stringent of any in the nation. Forklifts powered by LSI engines (gasoline and natural gas) are subject to new engine standards that include both criteria pollutant and durability requirements since 2001 with the cleanest requirements phased-in starting in 2010. Diesel Forklifts > 25 HP are subject to fleet average emission requirements under the Off-Road Diesel Regulation starting in 2010 and ***Tier 4 Off-Road Engine Standards*** (based on the use of advanced after-treatment technologies such as diesel particulate filters and selective catalytic reduction) starting in 2013. Furthermore, the stringency of these requirements is anticipated to increase under ***the Zero-Emission Off-Road Forklift Regulation Phase 1 measure*** committed to in the 2016 State SIP Strategy and the ***Off-Road Zero-Emission Targeted Manufacturer Rule measure***, committed to in the 2022 State SIP Strategy. Both of these measures would increase the deployment of zero-emission forklifts. No other state has more stringent forklift emission standards than CARB.

In-Use Controls: Forklifts

California forklifts are subject to either the ***LSI Fleet Regulation*** (if powered by gasoline or propane), and the ***Off-Road Diesel Fleet Regulation*** (if powered by diesel). Under both regulations, forklift fleets are required to retire, repower, or replace higher-emitting equipment in order to maintain fleet average standards. Under the 2022 Amendments to the ***In-Use Off-Road Diesel Fueled Fleets Regulation***, forklifts are also subject to requirements begin to transition fleets from the oldest and highest-emitting off-road engines in operation in California by phasing out Tier 0 – Tier 2 equipment beginning in 2024. Also beginning in 2024, the regulation includes requirements to restrict the addition of new vehicles and/or engines with Tier 3 and 4i engines. CARB is anticipated to further increase the stringency of emission controls the emissions for from forklifts operating at ports and intermodal rail yards through the ***Zero-Emission Cargo Handling Equipment Regulation*** measure, which begin transitioning to zero-emission technologies. Staff anticipates that all forklifts operating at ports and intermodal rail yards would be zero-emission by 2030. No other state or nonattainment area has more stringent fleet requirements for in-use forklifts than CARB.

Marine Engines

Emission Standards for Marine Engines

CARB's new engine standards for recreational boats are the most stringent of any in the nation, and exceed the stringency of U.S. EPA federal standards:

- The ***Exhaust Emission Regulations for Spark-Ignition Marine Engines*** (1998) controls emissions at the same level of stringency as national regulations;
- The ***Tier II Emission Standards for Inboard and Stern Drive Marine Engines*** (2001) controls emissions at the same level of stringency as national regulations; and
- The ***Evaporative Emission Control Standards*** (2015) exceeds the stringency of applicable national regulations set by U.S. EPA in 2008 for gasoline-fueled spark-ignition marine watercraft >30 kilowatts.

Furthermore, CARB is anticipated to increase the stringency of marine engine controls with the ***Spark-Ignition Marine Engine Standards measure,*** which would reduce emissions from new spark-ignition marine engines by adopting more stringent exhaust standards for outboard and personal watercraft, which currently do not use catalyst control technologies. No other state has the authority to set exhaust emission and/or evaporative emission standards that exceed the stringency of U.S. EPA's national standards.

Off-Highway Recreational Vehicles (OHRV)

Emission Standards for OHRV

CARB's new engine standards for OHRV are the most stringent of any in the nation. CARB's program sets ***Exhaust Emissions Standards and Evaporative Emission Standards for OHRVs,*** together with amendments to the testing procedures to ensure the most stringent level of emission reductions are achieved. CARB's exhaust emission standards control emissions from off-highway motorcycles, all-terrain vehicles, and

utility-terrain vehicles at more stringent levels than applicable national standards set by U.S. EPA for MY 2022 – 2027+. CARB evaporative emission standards harmonize with federal limits for MY 2020 – 2026. California's evaporative emission standards will exceed the stringency of federal requirements for MY 2027 and subsequent years. U.S. EPA has issued authorization for CARB's OHRV regulations. No other state or nonattainment area controls emissions from new OHRV more stringently than CARB.

In-Use Controls: OHRV

CARB's In-Use controls for OHRV under the ***"Red Sticker" program*** controls in-use emissions from OHRV more stringently than any other state or nonattainment area in the nation. Under this program, engines that do not meet the applicable emission standard for new engines are subject to in-use restrictions that limits operation at certain off-highway recreational vehicle parks located in ozone nonattainment areas during the summer peak ozone season. CARB is currently in the process of phasing out the Red Sticker program in favor of more stringent emission controls, and has ended Red Sticker certification of new OHRVs with no emission controls beginning in Model Year 2022. The seasonal riding restrictions on existing red sticker vehicles, however, continues through December 2024, providing for ongoing in-use emission controls for the legacy vehicle fleet. No other state or nonattainment area controls in-use emissions from OHRV more stringently than CARB.

Small Off-Road Engines (SORE)

Emission Standards for SORE

California's emission controls for SORE are the most stringent in the nation. CARB's current SORE program (through MY 2023) aligns the exhaust and evaporative standards for SORE with federal standards. CARB further increased the stringency of emission controls with the 2021 Amendments to the SORE Regulations, which will accelerate the deployment of zero-emission technologies, set tighter exhaust and evaporative emission standards, and enhance enforcement of current emission standards for SORE. Beginning in MY 2024, exhaust and evaporative emission standards were lowered to zero, except for pressure washers with engine displacement greater than or equal to 225 cubic centimeters, and generators (phase-in for ZE pressure washers and generators begins in MY 2028 and 2024, respectively). For MY 2024 and subsequent years, CARB's emission control requirements for SORE will exceed federal requirements. No other state has the authority to set exhaust emission and/or evaporative emission standards that exceed the stringency of U.S. EPA's national standards.

Transport Refrigeration Units (TRU)

Emission Standards for TRU

California's emission controls for Transport Refrigeration Units (TRU) are the most stringent in the nation. CARB adopted the ***Airborne Toxic Control Measure (ATCM) for In-Use Diesel-Fueled TRUs and TRU Generator Sets, and Facilities Where TRUs Operate (TRU ATCM)*** in 2004 and amended it in 2010 and 2011 to reduce diesel

particulate matter (PM) emissions and resulting health risk from diesel-powered TRUs used to control the environment of temperature-sensitive products. In 2022, CARB further amended the TRU ATCM (2022 Amendments), which included requirements that MY 2023 and newer trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines shall meet a PM emission standard of 0.02 grams per brake horsepower-hour or lower (aligns with the United States Environmental Protection Agency Tier 4 final off-road PM emission standard for 25-50 horsepower engines). Furthermore, CARB is anticipated to further increase the stringency of in-use emission controls on TRUs via the ***Transport Refrigeration Units Regulation Part 2 measure***, which would be designed to require zero-emission trailer TRUs, domestic shipping container TRUs, railcar TRUs, and TRU generator sets. No other state or nonattainment area requires as stringent of emission standards for TRUs.

In-Use Controls: TRU

CARB's ATCM for TRUs and TRU Generator Sets (***ATCM for In-Use Diesel-Fueled TRUs***) requires engines to meet in-use diesel PM emission standards by the end of the seventh year after manufacture, and applies to TRUs that operate in California, regardless of whether they are registered in or outside of the State. CARB's program is the most stringent of its type in the nation. Furthermore, CARB is anticipated to further increase the stringency of emission controls under the ***TRU Regulation Part 2 measure*** committed to in the 2022 State SIP Strategy, which is anticipated to increase NOx and PM emission reductions by reducing the amount of time TRUs operate while stationary. No other state or nonattainment area controls in-use emissions from TRUs more stringently than CARB.

Primarily Federally and Internationally Controlled Sources

Emission Standards for Locomotives

U.S. EPA sets nationwide emission standards for locomotives, the most recent of which is the Tier 4 NOx and PM Locomotive Emission Standards. No state, including California, has the authority to regulate emission standards for locomotives. Thus, CARB's locomotive controls are equivalent to the controls used in all other nonattainment areas in the nation. Nonetheless, further increases in stringency of locomotive emission controls are needed for California nonattainment areas, including the South Coast, to attain federal ambient air quality standards. For this reason, CARB has petitioned U.S. EPA to set more stringent emission controls for locomotives.

In-Use Emission Controls for Locomotives

While emission standards for locomotives are set by U.S. EPA, CARB has accelerated reductions from this source through efforts that have focused on increasing the use of cleaner locomotives. The ***2005 Statewide Rail Yard Agreement for California Rail Yards,*** a MOU obligated the railroads to increase the use of idle control devices, lowered locomotive idle times to 15 minutes, and opened a collaboration to produce Health Risk Assessments on 18 major railyards in the State which was completed in 2015. CARB also recently adopted more stringent in-use locomotive emission controls with the ***In-Use Locomotive Regulation***, which accelerates the adoption of advanced,

cleaner technologies for locomotive operations, including zero-emission technologies. No other state or nonattainment area has an agreement with Class I railroads to accelerate the introduction of cleaner locomotive engines, or has achieved similarly significant levels of emission reductions from in-use locomotives than CARB.

Emission Standards for Ocean-Going Vessels

The IMO, under Annex VI ("Regulations for the Prevention of Air Pollution from Ships"), specifies new engine NOx standards. Tier 2 IMO NOx standards have applied to new vessels since 2011, and Tier 3 NOx standards apply within NOx Emission Control Areas (ECAs) such as the North American ECA since 2016. However, the Tier 3 NOx limits are relatively high compared to the standards that apply to landside diesel engines. Annex VI regulations also do not limit PM exhaust emissions from new engines.

Neither CARB nor U.S. EPA have the regulatory authority to set emission limits for OGVs; thus no state, including California, has the authority to regulate emission standards for OGVs at levels different from those set by the IMO. Therefore, CARB's OGV emission standard controls are equivalent to the controls used in all other nonattainment areas in the nation. Nonetheless, further increases in stringency of OGV emission controls are needed for California nonattainment areas, especially the South Coast, to attain federal ambient air quality standards. For this reason, CARB, together with U.S. EPA, the Coast Guard, and international partners, continues to urge the IMO to adopt more stringent emission standards for new OGVs and efficiency requirements for existing vessels.

In-Use Emission Controls for Ocean-Going Vessels

CARB's ***Ocean-Going Vessel Fuel Regulation***, "Fuel Sulfur and Other Operational Requirements for Ocean-Going Vessels within California Waters and 24 Nautical Miles of the California Baseline," (2008) reduces PM, NOx, and sulfur oxide emissions from ocean-going vessels by requiring operators of OGVs to use less polluting marine distillate fuels instead of heavy fuel oil in their diesel engines and auxiliary boilers while operating within approximately 24 nautical miles (nm) of the California coastline. CARB's fuel requirements require the use of either marine gas oil (MGO) with a maximum sulfur limit of 1.5 percent, or marine diesel oil (MDO) with a maximum sulfur limit of 0.1%. Under Annex VI, the IMO sets fuel sulfur limits. The fuel sulfur limit in the North American Emission Control Areas (ECAs) is 0.1 percent sulfur, the same as CARB's Ocean-Going Vessel Fuel Regulation. However, there are some differences between the regulations. The California regulation specifies the use of cleaner "distillate" grades of fuel, rather than just a sulfur limit, and the federal ECA provides exemptions for many vessels that are not exempted by CARB's OGV Fuel Regulation.

In 2007, CARB adopted the ***Ocean-Going Vessels At Berth Regulation (At-Berth Regulation)***, which was amended in 2020. The At-Berth Regulation reduces emissions from vessels docked at California ports. At berth, auxiliary engines are used by vessels to run power for lighting, ventilation, pumps, communication, heating, and other onboard equipment while a vessel is docked. The At-Berth Regulation requires that vessels turn off their auxiliary diesel engines and plug in to shore-based grid electrical power, or utilize alternative technologies to achieve comparable emission reductions.

Although California is the only state in the United States that has a regulation requiring vessels to control emissions at berth, other states around the country have installed and are using shore power to control OGV emissions at berth. Seattle, New York, and New Jersey provide shore side power for cruise vessels.[118] In addition, the Port of Tacoma has provided shore power to container ships since 2010 and is adding shore power to be ready for use by the end of 2023. The Port of Miami has plans to install five shore power systems for cruise ships by the end of the year, which when finished, will be the largest shore power system in the world.[119]

CARB measure from the 2022 State SIP Strategy, ***Future Measures for Ocean-Going Vessel Emission Reductions***, considers available options to achieve further emissions reductions, including developing a statewide vessel speed reduction program, and/or through the use of operational changes and new technologies currently in development, including advances in exhaust capture and control, mobile shore power connections, cleaner fuels (such as LNG, hydrogen, methanol, ammonia, etc.), alternative power sources (including batteries and fuel cells), as well as potential vessel side technologies (such as water-in-fuel emulsion). The Port of Long Beach has employed a Green Ship Incentive Program since 2012 which is a voluntary program that incentivizes cleaner vessel visits, with incentives ranging from $600 to $6,000 depending on the vessel's ESI score.[120] The Port of Los Angeles also participates in the ESI Program, and provides incentives for Tier III vessels to come into port (incentive grant of $5,000 per call), and offers a Technology Advancement Program grant ($750 per call) for OGVs that demonstrate an emission reduction technology that reduces diesel particulate matter and NOx emissions.[121]

While there are no other states outside of California that regulate shipping emissions, other ports in the United States incentivize ships to use cleaner technology and practices that reduce emissions beyond the regulatory requirements set by the IMO. The Ports of New York and New Jersey's Clean Vessel Incentive Program offers financial incentives to encourage OGVs to voluntarily enhance their engines, fuel, and technology. The program employs a scoring system that rewards VSR and the vessel's Environmental Ship Index (ESI) score, with additional points given to vessels meeting clean engine standards.[122]

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[118] Shore Power Technology Assessment at U.S. Ports, 2022 Update, U.S. EPA, December 2022, https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1016C86.pdf

[119] MarineLog, PortMiami to deploy world's largest shore power system, February 16, 2023, https://www.marinelog.com/passenger/cruiseships/portmiami-to-deploy-worlds-largest-shore-power-system/#:~:text=The%20PowerCon%20system%20will%20provide,to%20bring%20shore%20power%20to

[120] Port of Long Beach, Port of Long Beach Increases Green Ship Incentive, May 26, 2021, https://polb.com/port-info/news-and-press/port-of-long-beach-increases-green-ship-incentive-05-26-2021/,

[121] The Port of Los Angeles, Port of Los Angeles Voluntary Environmental Ship Index Program, https://www.portoflosangeles.org/environment/air-quality/environmental-ship-index

[122] Port of New York and New Jersey, Clean Vessel Incentive Program, https://www.panynj.gov/port/en/our-port/sustainability/clean-vessel-incentive-program.html

In-Use Emission Controls for Aircraft

No state has emission standards for aircraft that differ from U.S. EPA's and FAA's. To control emissions from airport and aircraft related activities, including main aircraft engines, auxiliary power units (APU), and airport ground transportation, CARB has committed to the ***Future Measures for Aviation Emissions Reductions.*** Due to U.S. EPA's authority on setting emission standards, for this measure, CARB has identified opportunities for EPA to adopt cleaner emission standards for aircraft. Toward that end, CARB would strongly advocate U.S. EPA for stricter emission regulations and highlight the need to reduce pollution to protect public health.

FUELS

CARB Diesel Fuel Regulations

U.S. EPA began regulating sulfur content in diesel in 1993. At that time, uncontrolled fuels (i.e. non-CARB diesel) contained approximately 5,000 ppm of sulfur. In 2006, U.S. EPA began to phase-in more stringent requirements under the federal ULSD regulations, which lowered the amount of sulfur allowed in federal diesel fuels. U.S. EPA's Nonroad Diesel Fuel Standards were phased in from 2007 to 2014, and require that all off-road engines, including those used in locomotives and off-road equipment, use ULSD fuel (with some exemptions for older locomotives and marine engines). The Nonroad Standards also require that diesel fuel sold into the market for off-road use must be ULSD. It is important to note that while U.S. EPA defines ULSD as ≤ 15 ppm for on-road applications, the definition of off-road ULSD is significantly less stringent, defined as ≤ 500 ppm standard.

For the off-road fleet, CARB's current ULSD regulation is significantly more stringent than the applicable current federal ULSD standards (Phase III):

- Whereas the federal ULSD program differs in requirements for on- and off-road fuels, CARB's ultra-low sulfur diesel program sets the same requirements for fuels burned in on- and off-road applications. CARB limits sulfur content at 15 ppm rather than the federal limit of 500 ppm for off-road ULSD. Compared with CARB ULSD standards, federal off-road ULSD allows 33 times the sulfur content.
- CARB's ULSD significantly reduces emissions relative to federal on-road ULSD, which is much cleaner than federal off-road ULSD. Both federal on-road ULSD and CARB ULSD limit sulfur content (a precursor to secondary atmospheric formation of PM2.5) to 15 ppm, yet CARB's fuel emits ~25 percent less PM. Given that federal off-road ULSD sulfur content is capped at levels 3,000 percent higher than CARB's ULSD, the California program is significantly more stringent in terms of its ability to control emissions of sulfur oxide emissions.
- In addition, CARB controls hydrocarbons and aromatics, unlike U.S. EPA requirements.
- Furthermore, CARB is anticipated to further increase the stringency of controls on criteria pollutant emissions diesel products under the Low Emission Diesel measure committed to in the State SIP Strategy.

As was discussed in the on-road diesel fuel section, only one other state has a boutique fuel program with requirements that differ from federal specifications, the Low Emission Diesel Program in Texas (TxLED). An independent analysis of TxLED, CARB ULSD and federal ULSD shows that the TxLED fuel emissions performance does not provide as significant of emission reduction benefits as the California specifications.[123] Furthermore, the stringency of Texas' testing requirements are based on the federal Complex Model, which is less stringent and nuanced than the California Predictive Model that is used to determine compliance with California fuel requirements. CARB diesel specifications are more stringent than federal and other states' programs. CARB's ULSD program reduces NOx and PM emissions significantly relative to U.S. EPA requirements, providing approximately 7 percent more NOx reductions and 25 percent more diesel PM reductions than federal diesel. Furthermore, CARB is anticipated to further increase the stringency of controls on criteria pollutant emissions diesel products under ***the Low Emission Diesel measure***. No other state or nonattainment area controls criteria emissions from off-road diesel fuels more stringently than CARB.

Controlling Criteria Emissions from Renewable Fuels

The ***Low Carbon Fuel Standard (LCFS) and Alternative Diesel Fuel (ADF) regulations*** work together to reduce the carbon intensity of the California fuel supply while requiring limits on criteria emissions from alternative fuels and/or alternative fuel mix blends. While other states have adopted or are considering adopting similar programs to the California LCFS, no other state has set criteria emission requirements on alternative fuels and alternative fuel blends. The Federal Renewable Fuel Standard (RFS II), which is the most equivalent program type at the federal level, increases the renewable content of the fuel mix nationally (as the LCFS does in California), however it does not specify criteria requirements for alternative fuels. No other state or nonattainment area controls criteria emissions from renewable fuels more stringently than CARB.

[123] American Transportation Research Institute (ATRI) 2008 "Energy and Other Fuel Property Changes with On-Road Ultra-Low Sulfur Diesel Fuel" http://www.atri-online.org/research/results/environmentalfactors/2008ATRIDiesel.pdf

STEP 3(A): EVALUATION OF STRINGENCY: OFF-ROAD CONTROL MEASURES

Step 3(a) calls for an evaluation of each of the potential MSM control measures identified in Step 2, in order to evaluate their stringency and determine whether they meet all applicable requirements to satisfy the definitions of MSM as discussed in Section 1 and Section 2.

As shown in the Table 20 in Step 2(b), CARB's programs are the most stringent in the nation. This comparison between CARB's control measures and the measures currently in place at the Federal level and/or within other States and jurisdictions illustrates the stringency of the CARB off-road control program, which meets the stringency requirements of MSM.

Furthermore, CARB staff have conducted an analysis of the timing of the new measures included in the 2022 State SIP Strategy, which go beyond the stringency of the current control program as it is now being implemented. Many of these measures are still in their development phases and are not yet being implemented; the development timeline, however, is critical to allowing industry and technological advancements to progress sufficiently such that the newly emerging technologies called for in these regulatory actions (most of which are technology-inducing regulations) have sufficient time to attain market readiness. Table 21 summarizes the timeframe considerations for each of the applicable off-road control measures, and indicates why a more expedited timeframe is neither technologically nor economically feasible. For these reasons, the measures meet the MSM requirement of being phased in as "expeditiously as practicable".

Table 21: Off-Road Control Measures – Stringency and Timeline for Implementation

Measures	Implementation Begins	12 ug/m3 Annual (2012)
Off-Road Control Standards (General)		
Off-Road New Vehicle, Equipment and Engine Standards (General)		
Tier 4 Off-Road Engine Emission Standards	ongoing	MSM
Tier 5 Off-Road Vehicles and Equipment (2022 State SIP Strategy measure with commitment)	2029	MSM
California's emission standards for off-road diesel engines are consistent with those of U.S. EPA and the most stringent in the nation, with NOx limits at 0.3 g/bhp-hr, and PM limits at 0.015 g/bhp-hr. With the Tier 5 Off-Road Vehicles and Equipment Measure, CARB has committed to develop and propose standards and test procedures for new off-road CI engines More stringent PM and NOx standards for engines greater than or equal to 56 kW (75 hp). It is expected that Tier 5 requirements would rely heavily on technologies manufacturers are developing to meet the recently approved low-NOx standards and enhanced in-use requirements for on-road- heavy-duty engines. With the commitment to adopt Tier 5 emission standards, California's control program for new off-road engines will be further lowered to a nation-leading level; these levels will be technology-forcing, and will take years of lead time to enable manufacturers sufficient time to develop, test, certify, and manufacture the necessary low-emission engines and components. Further increases in stringency are not feasible. New off-road emission standards for new vehicles and engines are dependent on technological developments, and require years of lead time to be developed, certified, manufactured, and implemented; a more accelerated timeline is infeasible.		
Zero-Emission Off-Road New Equipment and Engine Standards (General)		
Off-Road Zero-Emission Targeted Manufacturer Rule (2022 State SIP Strategy measure with commitment)	2031	MSM
The Off-Road Zero-Emission Targeted Manufacturer Rule would accelerate the development and production of zero-emission off-road equipment and powertrains into more sectors (including wheel loaders, excavators, and bulldozers) as technology advancements occur due to existing CARB zero-emission regulations and regulations in the forklifts, cargo handling equipment, off-road fleets, and small off-road engines sectors. As a technology-forcing regulation, the Off-Road Zero-Emission Targeted Manufacturer Rule will accelerate the development and deployment of Zero-Emission off-road engines and powertrains; further increases in stringency are not feasible. Manufacturer sales requirements need years of lead time to be implemented; it would be infeasible to implement on a more accelerated timeframe.		
In-Use Control Measures – Off-Road Fleets (General)		
In-Use Off-Road Diesel-Fueled Fleets Regulation (Off-Road Regulation)	ongoing	MSM
2022 Amendments to the In-Use Off-Road Diesel-Fueled Fleets Regulation (2022 State SIP Strategy measure, adopted November 2022)	2024	MSM
Clean Off-Road Fleet Recognition Program (2022 State SIP Strategy measure with commitment)	2027	MSM
California's in-use emission controls for off-road equipment are the most stringent in the nation. CARB's off-road regulation controls diesel PM and NOx emissions from >150,000 in-use off road engines by requiring their owners to retire, replace, or repower older engines, and/or installing verified exhaust retrofit control technologies. Additionally, all vehicles are reported and labeled, and older, dirtier vehicles are restricted from entering fleets. The 2022 Amendments to the Off-Road Regulation create additional requirements to the currently regulated fleets by targeting the oldest and dirtiest equipment that is allowed to operate indefinitely under the current regulation's structure. The amendments will require fleets to phase-out use of the oldest and highest polluting off-road diesel vehicles in California, starting in 2024, and include changes to enhance enforceability and encourage the adoption of zero-emission technologies. CARB anticipates further emission reductions from the off-road equipment fleets through the Clean Off-Road Fleet Recognition Program measure, which would create a non-monetary incentive to encourage off-road fleets to go above and beyond existing regulatory fleet rule compliance and adopt advanced technology equipment with a strong emphasis on zero-emission technology. Fleet requirements need years of lead time to be implemented for reasons of technological and economic feasibility. As purchasing requirements and fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements. California's currently committed to off-road fleet requirements are technology-forcing and are the most stringent in the nation, requiring the lowest-emitting internal combustion engine and equipment technology, with zero-emission elements; further increases in stringency are not feasible.		

CARB Control Program MSM Analysis
for the SCAQMD 2024 12 µg/m^3 annual PM2.5 Plan

Measures	Implementation Begins	12 ug/m3 Annual (2012)
Off-Road Control Measures - Source Category Specific		
Agricultural Equipment		
Tier 4 Off-Road Engine Emission Standards	ongoing	MSM
U.S. EPA and California adopted equivalent Tier 4 standards in 2004 that require additional emission reductions from off-road engines, including those used in mobile agricultural equipment. No State has more stringent requirements for new emission performance standards for agricultural equipment engines than California. Further increases in stringency, or an accelerated timeline for implementation are not feasible.		
Funding Agricultural Replacement Measures for Emission Reductions (FARMER) Program	ongoing	MSM
California's in-use emission control program for agricultural equipment is among the most stringent in the nation. The Funding Agricultural Replacement Measures for Emission Reductions (FARMER) Program provides funding through local air districts for agricultural harvesting equipment, heavy-duty trucks, agricultural pump engines, tractors, and other equipment used in agricultural operations. Local air districts receive funds based on a formula and award them to farmers and agricultural businesses for individual projects. Funding is supported in part by California Climate Investments, a statewide program that puts billions of Cap-and-Trade dollars to work. In April 2022, CARB expanded the project categories within the FARMER Program to include zero-emission agricultural equipment. As of September 2022, $685 million has been allocated, with $347.6 million implemented across 8,057 projects. The emission reductions benefits associated with these projects include 22,400 tons of NO_x reductions, and 1,350 tons of PM 2.5 reductions, Statewide. California's agricultural equipment fleet rules are among the most stringent in the nation; further increases in stringency are not feasible. Fleet turnover programs need years of lead time to be implemented for reasons of technological and economic feasibility; because fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements.		
Airport Ground Support Equipment (GSE)		
Tier 4 Off-Road Engine Emission Standards	ongoing	MSM
LSI Engine Fleet Requirements Regulation	ongoing	MSM
In-Use Off-Road Diesel-Fueled Fleets Regulation (Off-Road Regulation)	ongoing	MSM
Portable Diesel-Engine ATCM	ongoing	MSM
Zero-Emission Airport Ground Support Equipment (GSE) (2016 State SIP Strategy measure, not yet adopted)	TBD	MSM
California's emission controls for Airport Ground Support Equipment (GSE) are the most stringent in the nation: • Diesel engines in newly manufactured GSE must meet the Tier 4 Emission Standards applicable to off-road compression ignition engines; • NOx limits for the LSI Engine Standard for engines > 1.0 liter (the typical engine size for GSE) is 0.6 g/bhp-hr. Engines meeting this standard are 70 percent cleaner than LSI engines produced as recently as 2009; • Airport GSE fleets operating LSI GSE must meet the In-Use LSI Engine Fleet Requirements. Adopted in 2006, the LSI fleet rule requires GSE fleets to maintain an average emission level of no more than 2.5 g/bhp hr HC+NOx; • The In-Use Off-Road Diesel-Fueled Fleets Regulation requires GSE fleets operating in-use diesel equipment to meet an annual fleet average emissions target that decreases over time, which are currently being phased in; • Non mobile GSE such as portable air-start units, ground power units and air conditioners may be subject to the Portable Diesel-Engines ATCM; • CARB is anticipated to further increase the stringency of emission controls with the Zero-Emission Airport Ground Support Equipment measure, which will act as a catalyst to further adoption of zero-emission equipment. The stringency of California's control program for Airport GSE leads the nation, and will be further lowered with the Zero-Emission Airport GSE measure; these levels will be technology-forcing, and will take years of lead time to enable manufacturers sufficient time to develop, test, certify, and manufacture the necessary low-emission engines and components. Further increases in stringency are not feasible. New emission standards and fleet requirements for GSE are dependent on technological developments, and require years of lead time to be developed, certified, manufactured, and implemented; a more accelerated timeline is infeasible.		
Cargo Handling Equipment (CHE)		
Cargo Handling Equipment (CHE) Regulation	ongoing	MSM

Measures	Implementation Begins	12 ug/m3 Annual (2012)
Amendments to CHE Regulation (2022 State SIP Strategy measure with commitment)	2026	MSM
California's emission controls for Cargo Handling Equipment (CHE) are the most stringent in the nation. CARB's Cargo Handling Equipment regulation sets performance standards for newly acquired engines, as well as in-use mobile CHE at ports or intermodal rail yards. The CHE regulation also includes performance standards for in-use, mobile CHE at ports or intermodal rail yards in California. CARB is anticipated to further increase the stringency of the CHE Regulation by transitioning CHE to zero-emission beginning in 2026. As committed to in the 2022 State SIP Strategy, CARB's amendments to the Cargo Handling Equipment Regulation would set in-use requirements for diesel cargo handling equipment at ports and rail yards, including but not limited to: yard trucks (hostlers), rubber-tired gantry cranes, container handlers, and forklifts. CARB's control measures are the most stringent in the nation, and the requirements committed will be technology-forcing and the most stringent feasible, including zero-emission requirement; further increases in stringency are not feasible. New standards for CHE are dependent on technological developments, and require years of lead time to be developed, certified, manufactured, and implemented; a more accelerated timeline is infeasible.		
Commercial Harbor Craft (CHC)		
Commercial Harbor Craft (CHC) Regulation	ongoing	MSM
2022 Amendments to CHC Regulation 2022 State SIP Strategy measure, adopted May 2022)	ongoing	MSM
California's emission controls for commercial harbor craft (CHC) are the most stringent in the nation. As amended in 2011, CARB's CHC Regulations reduce NOx and diesel PM emissions from crew and supply boats, ferries, excursion vessels, towboats, push boats, tugboats, barges, and dredges, and included in-use limits that required diesel PM and NOx emission controls. CARB amended the CHC regulation in 2022, establishing expanded and more stringent in-use requirements to cover more vessel categories including all tank barges, pilot vessels, research vessels, workboats, commercial passenger fishing, and commercial fishing vessels. The amendments also mandate accelerated deployment of zero-emission and advanced technologies in vessel categories where technology feasibility has been demonstrated. CARB's CHC control measures are technology forcing and the most stringent in the nation; further increases in stringency are infeasible. The requisite technology developments need years of lead time for development, certification, and implementation; it is not technologically feasible to accelerate the implementation timeline.		
Forklifts		
Tier 4 Off-Road Engine Emission Standards	ongoing	MSM
In-Use LSI Engine Fleet Requirements	ongoing	MSM
In-Use Off-Road Diesel-Fueled Fleets Regulation (Off-Road Regulation)	ongoing	MSM
Zero-Emission Off-Road Forklift Regulation Phase 1 (2016 State SIP Strategy measure with commitment)	2026	MSM
Amendments to the CHE Regulation (2022 State SIP Strategy measure with commitment)	2026	MSM
Off-Road Zero-Emission Targeted Manufacturer Rule (2022 State SIP Strategy measure with commitment)	2031	MSM

California's emission controls for forklifts are the most stringent in the nation. Forklifts powered by LSI engines (gasoline and natural gas) are subject to new engine standards that include both criteria pollutant and durability requirements. Diesel Forklifts > 25 HP are subject to Tier 4 Final emission standards (based on the use of advanced after-treatment technologies such as diesel particulate filters and selective catalytic reduction). Under the 2022 Amendments to the In-Use Off-Road Diesel Fueled Fleets Regulation, forklifts are also subject to requirements begin to transition fleets from the oldest and highest-emitting off-road engines in operation in California by phasing out Tier 0 – Tier 2 equipment beginning in 2024. Also beginning in 2024, the regulation includes requirements to restrict the addition of new vehicles and/or engines with Tier 3 and 4i engines. CARB is anticipated to further increase the stringency of emission controls:

- The Zero-Emission Off-Road Forklift Regulation Phase I measure would be designed to accelerate the deployment of zero-emission forklift technologies, with an implementation schedule beginning in 2026;
- For forklifts operating at ports and intermodal rail yards, the Amendments to the Cargo Handling Equipment Regulation measure that CARB committed to in the 2022 State SIP Strategy measure would also require transitioning to zero-emission technologies. Staff anticipates that all forklifts operating at ports and intermodal rail yards would be zero-emission by 2030;
- The Off-Road Zero-Emission Targeted Manufacturer Rule measure would further increase the stringency of emission controls for forklifts, transitioning more fully to zero-emission powertrains.

The stringency of California's forklift control program leads the nation, and will be further lowered with the Zero-Emission Off-Road Forklift Regulation Phase 1, the Amendments to CHE Regulation, and the Off-Road Zero-Emission Targeted Manufacturer Rule measures; the levels committed to with these measures will be technology-forcing, and will take years of lead time to

Measures	Implementation Begins	12 ug/m3 Annual (2012)
enable manufacturers sufficient time to develop, test, certify, and manufacture the necessary low-emission engines and components. Further increases in stringency are not feasible. New emission standards and fleet requirements for forklifts are dependent on technological developments, and require years of lead time to be developed, certified, manufactured, and implemented; a more accelerated timeline is infeasible		
Marine Engines		
Exhaust Emission Regulation for Spark-Ignition Marine Engines	ongoing	MSM
Tier II Emission Standards for Inboard and Stern-Drive Marine Engines	ongoing	MSM
Marine Engine Evaporative Emission Control Standards	ongoing	MSM
Amendments to Spark-Ignition Marine Engine Standards (2022 State SIP Strategy measure with commitment)	2031	MSM
CARB's recreational boats and marine engine program exceeds the stringency of U.S. EPA's federal standards and are the most stringent in the nation: • The Exhaust Emission Regulations for Spark-Ignition Marine Engines (1998) controls emissions at the same level of stringency as national regulations; • The Tier II Emission Standards for Inboard and Stern Drive Marine Engines (2001) controls emissions at the same level of stringency as national regulations; and • The Evaporative Emission Control Standards (2015) exceeds the stringency of applicable federal regulations set by U.S. EPA in 2008 for gasoline-fueled SI marine watercraft >30 kilowatts. The Spark-Ignition Marine Engine Standards measure would reduce emissions from new spark-ignition (SI) marine engines by adopting more stringent exhaust standards for outboard and personal watercraft, which currently do not use catalyst control technologies. Staff estimates that stricter standards could reduce combined HC or ROG and NOx emissions by approximately 70 percent below the current HC+NOx standard. CARB staff is also evaluating whether some outboard and personal watercraft vessels could be propelled by zero-emission technologies in certain applications. California's control program for marine engines is currently the most stringent in the nation, and will be further lowered with the Spark-Ignition Marine Engine Standards measure; these levels will be technology-forcing, and will take years of lead time to enable manufacturers sufficient time to develop, test, certify, and manufacture the necessary low-emission engines and components. Further increases in stringency are not feasible. New marine engine emission standards are dependent on technological developments, and require years of lead time to be developed, certified, manufactured, and implemented; a more accelerated timeline is infeasible.		
Off-Highway Recreational Vehicles (OHRV)		
Exhaust and Evaporative Emission Standards for OHRVs	ongoing	MSM
California's emission controls for Off-Highway Recreational Vehicles (OHRVs) are the most stringent in the nation. CARB's exhaust emission standards and evaporative emission standards control emissions from motorcycles, all-terrain vehicles, and utility-terrain vehicles at more stringent levels than applicable national standards set by U.S. EPA for MY 2022 – 2027+. CARB evaporative emission standards harmonize with federal limits for MY 2020 – 2026, and will exceed the stringency of federal requirements for MY 2027+. CARB's "Red Sticker" program requires in-use OHRVs that do not meet the applicable exhaust emission standards display a red registration sticker that limits operation at certain off highway recreational vehicle parks located in nonattainment areas during peak ozone season. CARB's OHRV program is the most stringent in the nation; further increases in stringency or an accelerated implementation timeframe are not feasible.		
Small Off-Road Engines		
SORE Exhaust Emission Standards and Test Procedures	ongoing	MSM
Evaporative Emission Standards for SORE	ongoing	MSM
2021 Amendments to the Small Off-Road Engines (SORE) Regulation	2024	MSM
California's emission controls for small off-road engines (SORE) are the most stringent in the nation. CARB's current SORE program (through MY 2023) aligns the exhaust and evaporative standards for SORE with federal standards, and sets requirements for Zero-Emission SORE equipment. CARB further increased the stringency of emission controls with the 2021 Amendments to the SORE Regulations, which will accelerate the deployment of zero-emission technologies, set tighter exhaust and evaporative emission standards (MY 2024+), and enhance enforcement of current emission standards for SORE. Beginning in MY 2024, exhaust and evaporative emission standards were lowered to zero, except for pressure washers with engine displacement greater than or equal to 225 cubic centimeters and generators (phase-in for ZE pressure washers and generators begins in MY 2028 and 2024, respectively). As a technology-forcing regulation, the SORE Regulation will accelerate the development and deployment of zero-emission SORE; further increases in stringency are not feasible. New exhaust and evaporative emission standards need years of lead time to be implemented; it would be infeasible to implement on a more accelerated timeframe.		
Transport Refrigeration Units (TRUs)		
ATCM for In-Use Diesel-Fueled Transport Refrigeration Units (TRUs) and TRU Generator Sets	ongoing	MSM

Measures	Implementation Begins	12 ug/m3 Annual (2012)
Transport Refrigeration Unit Regulation Part 2 (2022 State SIP Strategy measure with commitment)	2028	MSM

California's emission controls for Transport Refrigeration Units (TRU) are the most stringent in the nation. Amended in 2022, the TRU ATCM requires that MY 2023 and newer trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines meet a PM emission standard of 0.02 grams per brake horsepower-hour or lower (aligns with the United States Environmental Protection Agency Tier 4 final off-road PM emission standard for 25-50 horsepower engines). Beginning December 31, 2023, TRU owners shall turnover at least 15 percent of their truck TRU fleet (defined as truck TRUs operating in California) to ZE technology each year (for seven years). All truck TRUs operating in California shall be ZE by December 31, 2029. CARB has committed to increasing the stringency of TRU controls with the TRU Regulation Phase 2, which would establish zero-emission options for non-truck TRUs. These levels will be technology-forcing, and will take years of lead time to enable manufacturers sufficient time to develop, test, certify, and manufacture the necessary low-emission engines and components. Further increases in stringency are not feasible. New emission standards and zero-emission requirements for TRUs are dependent on technological developments, and require years of lead time to be developed, certified, manufactured, and implemented; a more accelerated timeline is infeasible.

In-Use Emission Control Measures for Primarily Federally and Internationally Regulated Sources

In-Use Railroad Control Measures

Statewide Rail Yard Agreement for California Rail Yards (Railroad MOU)	ongoing	MSM
In-Use Locomotive Regulation (2022 State SIP Strategy measure, adopted April 2023)	2024	MSM

U.S. EPA has the sole authority to establish emissions standards for locomotives. California's in-use emission reduction measures for locomotives are the most stringent in the nation. The 2005, Statewide Rail Yard Agreement for California Rail Yards, a Memorandum of Understanding (MOU) with the Class I Railroads to increase the use of idle control devices, lowered locomotive idle times to 15 minutes, and opened a collaboration to produce Health Risk Assessments on 18 major railyards in the state was completed in 2015. Adopted in April 2023, the In-Use Locomotive Regulation accelerates the adoption of advanced, cleaner technologies for locomotive operations, including zero-emission technologies. The regulatory elements include:

- Starting in 2024: Spending Account
  Locomotive operators would be required to fund their own trust account based on the emissions created by their locomotive operations in California. The dirtier the locomotive, the more funds must be set aside. Spending Account funds would be used to fund turnover to cleaner locomotives, rail equipment, and/or related infrastructure.
- Starting in 2024: Idling Limit
  All locomotives with automatic shutoff devices (AESS) would not be permitted to idle longer than 30 minutes, unless for an exempt reason. Exemptions closely align with those described by U.S. EPA., and would be granted for reasons like maintaining air brake pressure or to perform maintenance.
- Starting in 2030: In-Use Operational Requirements
  Only locomotives less than 23 years old would be able to be used in California. Switchers, industrial, and passenger locomotives with original engine build dates of 2030 or newer would be required to operate in a ZE configuration in California. Freight line haul locomotives with original engine build dates of 2035 and newer would be required to operate in a ZE configuration in California.

CARB's in-use emission controls for locomotives are the most stringent in the country, and with the In-Use Locomotive Regulation, which includes zero-emission elements, stringency will be increased further; these requirements are technology-forcing and additional increases in stringency are not feasible. Fleet requirements need years of lead time to be implemented; it would be infeasible to accelerate the implementation timeframe.

In-Use Ocean-Going Vessel Control Measures

Ocean-Going Vessel Fuel Regulation	ongoing	MSM
Ocean-Going Vessels At-Berth Regulation (At-Berth Regulation)	ongoing	MSM
Future Measures for Ocean-Going Vessel Emissions Reductions (2022 State SIP Strategy measure, not yet adopted)	2027+	MSM

CARB Control Program MSM Analysis
for the SCAQMD 2024 12 µg/m^3 annual PM2.5 Plan

Measures	Implementation Begins	12 ug/m3 Annual (2012)
The International Maritime Organization (IMO) has the sole authority to establish emissions standards for ocean-going vessels. California's in-use emission reduction measures for OGVs are the most stringent in the nation. The 2008 Ocean Going Vessel Fuel Regulation reduces PM, NOx, and SOx emissions from ocean-going vessels by requiring operators of OGVs to use less polluting marine distillate fuels instead of heavy fuel oil in their diesel engines and auxiliary boilers while operating within approximately 24 nautical miles (nm) of the California coastline. The At-Berth Regulation, which was amended in 2020, reduces emissions from vessels docked at California ports by requiring that vessels turn off their auxiliary diesel engines and plug in to shore-based grid electrical power, or utilize alternative technologies to achieve comparable emission reductions. With the Future Measures for Ocean-Going Vessel Emissions Reductions measure, which may include developing a statewide vessel speed reduction program, and/or through the use of operational changes and new technologies currently in development, including advances in exhaust capture and control, mobile shore power connections, cleaner fuels (such as LNG, hydrogen, methanol, ammonia, etc.), alternative power sources (including batteries and fuel cells), as well as potential vessel side technologies (such as water-in-fuel emulsion), stringency will be increased further; these requirements are technology-forcing and additional increases in stringency are not feasible. Fleet requirements need years of lead time to be implemented; it would be infeasible to accelerate the implementation timeframe.		
In-Use Aviation Control Measures		
Future Measures for Aviation Emission Reductions (2022 State SIP Strategy measure with commitment)	2029	MSM
The authority to establish emissions standards for aircraft lies at the federal level; no state has emission standards for aircraft that differ from those set by U.S. EPA and the FAA. CARB's Future Measures for Aviation Emissions Reductions would reduce in-use emissions from airport and aircraft related activities, including main aircraft engines, auxiliary power units (APU), and airport ground transportation. These emission control strategies would be nation-leading in terms of stringency; further increases in stringency are not feasible. These strategies are also dependent on technological and operational developments, and require sufficient lead time for regulated parties to comply; an accelerated implementation timeline would not be feasible.		
Fuels Control Measures		
Conventional Diesel Fuel Standards		
CARB Ultra Low Sulfur Diesel (ULSD)	ongoing	MSM
Low-Emission Diesel Requirement (2016 State SIP Strategy measure, not yet adopted)	TBD	MSM
CARB's Ultra Low Sulfur Diesel regulation was last amended 2003 to establish more stringent standards for diesel fuel, lowering the sulfur limit to 15 ppmw. The California Diesel Fuel Regulations apply to essentially all diesel fuel supplied, sold, or offered for sale in California. The original applicability of the regulations was to vehicular diesel fuel; however, the applicability of the regulations has been extended by the adoption of ATCMs to non-vehicular diesel fuel, such as fuel for stationary engines, locomotives, and marine harbor craft. The Low Emission Diesel measure would require diesel fuel providers to steadily decrease criteria pollutant emissions from their fuels, which will reduce NOx and PM tailpipe emissions. CARB fuel regulations reduce emissions from even those vehicles registered out of state and therefore not subject to CARB's other mobile source control measures. CARB's diesel standards and requirements are the most stringent in the nation, and some of the most stringent in the world; it is not feasible to require further stringency of fuel specifications.		
Alternative Fuel Standards		
Low Carbon Fuel Standard (LCFS)	ongoing	MSM
Alternative Diesel Fuel (ADF)	ongoing	MSM
California's fuel standards for diesel substitutes are the most stringent in the nation. The LCFS and ADF regulations work together to reduce the carbon intensity of the California fuel supply while requiring limits on criteria emissions from alternative fuels and/or alternative fuel mix blends (due to regulatory constraints, the LCFS and ADF do not apply to aviation gasoline, nor fuels used in interstate locomotives and ocean-going vessels – regulatory control over these fuels lies at the national and international level). The regulations were amended in 2018 to extend the carbon intensity target of 20 percent to 2030. No other state or federal requirements have set as stringent of criteria emission requirements on alternative fuels and alternative fuel blends than California. The LCFS and ADF are technology-forcing regulations, and are the most stringent in the nation; further stringency would not be feasible. As it takes fuel producers years to develop, certify, and manufacture new alternative fuel types to meet the increasingly stringent requirements of the LCFS and ADF, an accelerated implementation timeframe would not be feasible.		

STEP 3(B): EVALUATION OF FEASIBILITY: OFF-ROAD CONTROL MEASURES

Step 3(b) calls for an assessment of the feasibility of implementing any measure that is not included in the proposed South Coast SIP, but which is identified as a potential MSM control measure in Step 2. During the public process for the 2022 State SIP Strategy, CARB staff received a public measure suggestion for an additional potential control measure, as described below:

- Indirect Source Rule
  This measure could involve CARB writing a Suggested Control Measure which acts as a model rule to assist the air districts in the rule development process. An indirect source can be any facility, building, structure, or installation, or combination thereof, which attracts or generates mobile source activity that results in emissions – these include warehouses, railyards, ports, airports, and mobile sources attracted to those warehouses, railyards, ports, and airports. Only a few air districts in California have indirect source rules to limit emissions of this nature on a facility basis.

  CARB staff has been investigating the feasibility and potential benefits of this suggested measure, and is continuing to explore this suggested measure and how it can meet the Clean Air Act requirements for SIP measure approvability. CARB staff has also been exploring its feasibility, given the current limitations of State law and the nature of how emission control authority is designated amongst CARB and local air districts. (How do we want to phrase this limit to our statutory authority?) Nonetheless, CARB staff have included an Indirect Source Rule as one potential element of the ***Zero-Emission Trucks measure*** committed to in the 2022 State SIP Strategy. In addition, CARB staff will explore opportunities to expand existing State law to provide partnership opportunities for CARB and air districts to work together to develop, adopt, and implement indirect source rules.

CARB staff continue to investigate the feasibility of this public measure suggestion, as well as whether it would meet the U.S. EPA's approvability criteria for SIP measures, and legal questions around statutory authority as designated to CARB and the air districts. While CARB staff have included an Indirect Source Rule as one potential element of the Zero-Emission Trucks measure, due to feasibility and approvability issues, this suggestion has not yet been formally organized into a SIP control measure.

Commercial and Residential Building Appliances

STEP 2(A): CALIFORNIA'S COMMERCIAL AND RESIDENTIAL BUILDING APPLIANCES CONTROL MEASURE

In the 2022 State SIP Strategy, CARB committed to achieving emissions reductions for combustion sources used in buildings through the ***Zero Emission Standard for Space and Water Heaters measure***. The primary goal of this measure is to reduce emissions from new residential and commercial space and water heaters sold in California. CARB would set a zero-emission standard for space and water heaters to go into effect in 2030. This measure would be the first time CARB would be regulating these sources of emissions which are also subject to various other requirements at the State and local levels. As such, CARB would design any such standard in collaboration with energy and building code regulators, and with air districts, to ensure it was consistent with all state and local efforts.

The South Coast AQMD controls NOx emissions from residential space and water heaters through two rules: Rule 1121 – Control of Oxides of Nitrogen (NOx) from Residential Type, Natural Gas-Fired Water Heaters; and Rule 1111 – Reduction of NOx Emissions from Natural-Gas Fired, Fan-Type Central Furnaces, which regulates residential space heating sources.

Rule 1111 reduces NOx emissions from residential and commercial gas-fired fan-type space heating furnaces with a rated heat input capacity of less than 175,000 BTU per hour or, for combination heating and cooling units, a cooling rate of less than 65,000 BTU per hour. The rule applies to manufacturers, distributors, and installers of such furnaces. The rule was originally adopted in 1978, and has been subsequently amended, including a 2009 amendment that lowered the NOx emissions from 40 to 14 nanograms per Joule (ng/J), and a 2014 amendment that provided an alternate compliance option that allows the manufacturer to pay a per-unit mitigation fee, in lieu of meeting the new lower NOx emission limit, for up to 36 months past the applicable compliance date.[124]

Rule 1121, which was last amended in 2004, applies to manufacturers, distributors, retailers, and installers of natural gas-fired water heaters, with heat input rates less than 75,000 Btu per hour. The most stringent limits in SCAQMD Rule 1121 went into effect for all applicable units less than 75,000 Btu/hr between 2006 and 2008, and require a 10 ng/J standard for gas-powered water heaters.[125]

The South Coast AQMD controls NOx emissions from commercial and industrial space and water heaters through three rules:

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[124] SCAQMD 2021 *Preliminary Draft Staff Report Proposed Amended Rule 1111 – Reduction of NOx Emissions from Natural Gas-Fired, Fan-Type Central Furnaces* https://www.aqmd.gov/docs/default-source/rule-book/Proposed-Rules/1111/par-1111_preliminary-draft-staff-report_june-18-2021.pdf?sfvrsn=6#:~:text=Rule%201111%20reduces%20emissions%20of,than%2065%2C000%20BTU%20per%20hour.

[125] SCAQMD 2004 RULE 1121 Control of NOx from Residential Type, Natural Gas-Fired water Heaters http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1121.pdf

- Rule 1146: Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters applies to existing boilers, steam generators, and process heaters with maximum rated heat input capacities greater than or equal to 5 million British thermal units per hour (MMBtu/hr);
- Rule 1146.1: Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters applies to boilers, steam generators, and process heaters with maximum rated heat input capacities greater than 2 MMBtu/hr and less than 5 MMBtu/hr;
- Rule 1146.2: Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters establishes NOx emission limits for large water heaters, boilers and process heaters less than or equal to 2 MMBtu/hr.

Rules 1146, 1146.1 and 1146.2 update NOx emission limits for boilers, heaters, and steam generators applicable to these rules. The revised NOx emission limits represent BARCT and apply to former RECLAIM and non-RECLAIM facilities. Table *22* summarizes the applicability and existing NOx emission limits in Rules 1146, 1146.1 and 1146.2.[126]

Table 22: Applicability and NOx Limits for Rules 1146, 1146.1, and 1146.2

Rule	Applicability	Size	Summary of NOx Emission Limits
1146	Boilers, steam generators, and process heaters	≥ 5 MMBtu/hr	• 5 ppm for units burning natural gas ≥ 75 MMBtu/hr • 9 ppm for units burning gaseous fuels 5 to 75 MMBtu/hr • 30 ppm for thermal fluid heaters burning gaseous fuels • 40 ppm for nongaseous fuels • 12 ppm for atmospheric units • 15 ppm for units burning digester gas • 25 ppm for units burning landfill gas
1146.1	Boilers, steam generators, and process heaters	> 2 and < 5	• 9 ppm for units burning natural gas • 30 ppm for thermal fluid heaters burning gaseous fuels • 12 ppm for atmospheric units • 15 ppm for units burning digester gas • 25 ppm for units burning landfill gas
1146.2	Natural gas-fired water heaters, boilers, and process heaters	≤ 2 MMBtu/hr	• Manufacturer limit of 20 ppm • End-user limit of 30 ppm

[126] SCAQMD 2018, "PARs 1146, 1146.1 and 1146.2, and PR 1100 Final Staff Report" http://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2018/2018-dec7-028.pdf?sfvrsn=6

During the adoption of the 2016 AQMP, the South Coast AQMD Board directed staff to transition the NOx RECLAIM program to a command-and-control regulatory structure requiring Best Available Retrofit Control Technology (BARCT) as soon as practicable. In December 2018, the South Coast AQMD Board adopted source-specific rules establishing BARCT emission limits, which are needed for equipment at former RECLAIM facilities as they transition to a command-and-control regulatory program. The 2018 Amendments to Rules 1146, 1146.1 and 1146.2 updated NOx emission limits for boilers, heaters, and steam generators. The revised NOx emission limits represent BARCT and apply to former RECLAIM and non-RECLAIM facilities. Facilities with Rule 1146/1146.1 units had until January 1, 2022 to retrofit all existing units, and until January 1, 2023 to replace any existing units. Rule 1146.2 units (between 400,000 to 2 million British thermal units per hour) are required to comply with the 30 ppm limit by December 31, 2023.

Additionally, in their *2022 Air Quality Management Plan*, the South Coast AQMD has committed to develop zero-emission standards for commercial and residential space and water heaters in installations in both new and existing residences, in addition to incentive-based strategies.[127]

As previously mentioned, CARB committed in the 2022 State SIP Strategy to achieving additional emissions reductions for combustion sources used in buildings through the ***Zero Emission Standard for Space and Water Heaters measure***. Through meaningful engagement with communities and the process outlined below, CARB would adopt a statewide zero-emission standard which would have criteria pollutant benefits as a key result along with GHG reductions. Beginning in 2030, 100 percent of sales of new space heaters and water heaters would need to comply with the emission standard. CARB would design any such standard in collaboration with energy and building code regulators, and with air districts, to ensure it was consistent with all State and local efforts, and would work carefully with communities to consider any housing cost or affordability impacts, recognizing that reducing emissions from space and water heaters can generate health benefits and cost-savings with properly designed standards.

CARB understands that this measure needs to be part of a suite of equity-promoting and complementary building decarbonization policies deeply informed by public process that include scaling back natural gas infrastructure, expanding construction of zero-emission buildings, and building a sustainable market by increasing affordability and accessibility through expanding incentive programs, ensuring utility rates are supportive of electrification, developing the workforce, and increasing consumer education. Although this measure is the only component appropriate for including in the SIP, before setting an emission standard, CARB will work in collaboration with other agencies, industry, environmental stakeholders, and community representatives to ensure that the measure is developed and implemented in an equitable manner to

[127] SCAQMD. *2022 Air Quality Management Plan*. December 2, 2022. Retrieved from: http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2022-air-quality-management-plan/final-2022-aqmp/final-2022-aqmp.pdf?sfvrsn=10

benefit low-income and disadvantaged communities. As such, community engagement will be a critical aspect of the entire process. Furthermore, as this proposal is developed, this measure may be expanded to include other end-uses.

For this measure, CARB would develop and propose zero-emission standards for space and water heaters sold in California using its regulatory authority for GHGs (which includes consideration of related criteria pollutant reduction benefits). CARB would collaborate with the U.S. Department of Energy and the California Energy Commission which are responsible for establishing appliance standards focused on maximizing energy efficiency at the federal and state level. CARB would consult with the California Building Standards Commission, Housing and Community Development and the California Energy Commission which have authority to develop building standards for new construction, additions, and alterations of residential and commercial buildings to ensure this measure is complementary. At the regional level, CARB would work with air districts in the development of a statewide zero-emission standard and to support further tightening district rules to drive increased adoption of zero-emission technologies. Finally, CARB would engage with community-based organizations and other key stakeholders to incorporate equitable considerations for low-income and environmental justice communities where feasible. This proposed measure is a key component of a broader portfolio of strategies to advance equitable building decarbonization in California. This measure would not mandate retrofits in existing buildings, but some buildings would require retrofits to be able to use the new technology that this measure would require. Beginning in 2030, 100 percent of new space and water heaters (for either new construction or replacement of burned-out equipment in existing buildings) sold in California would need to meet the zero-emission standard.

This measure has the potential to significantly accelerate the transition away from pollution associated with combustion in these sources, while creating economic opportunities for building retrofits. CARB staff has been analyzing the feasibility and potential benefits of this measure and expect that this regulation would rely heavily on currently-available heat pump technologies, which are now being sold to electrify new and existing homes. CARB staff have included in the Zero Emission Standard for Space and Water Heaters measure the potential to expand beyond space and water heaters to include additional end-uses as suggested via a public measure suggestion.

In addition to the proposed standard for space and water heaters, California has in place programs to ensure weatherization and energy efficiency of new buildings. The State of California's Building Energy Efficiency Standards for Residential and Nonresidential Buildings (California Energy Code, Title 24, Part 6) are in effect Statewide and affect both new builds and alterations of existing buildings. The Building Energy Efficiency Standards were last updated in 2022 (effective as of January 1, 2023); the 2022 updates set in place new standards to encourage building decarbonization, emphasizing in particular on heat pumps for space heating and water

heating, and extended the benefits of photovoltaic and battery storage systems and other demand flexible technology to work in combinations with heat pumps.

California also has a number of funding programs, including the California Department of Community Services and Development's (CSD) Low-Income Weatherization Program to provides low-income households with solar photovoltaic systems and energy efficiency upgrades at no cost to residents, including specific components to support low-income farmworkers and multi-family properties. The California CSD also provides additional resources and administers certain federal weatherization programs including the U.S. Department of Energy's Weatherization Assistance Program, and the U.S. Department of Health and Human Services' Low-Income Home Energy Assistance Program; California CSD works with local energy services providers throughout the state installing weatherization and energy efficiency measures for low-income homeowners and renters to facilitate these programs. Further, the California Public Utilities Commission has an Energy Savings Assistance Program which provides no-cost weatherization services to consumers who meet the income limits under the California Alternate Rates for Energy program.

STEP 2(B): OTHER STATES' AND NONATTAINMENT AREAS' COMMERCIAL AND RESIDENTIAL BUILDING APPLIANCES CONTROL MEASURES

Table 23 summarizes the most stringent control measures currently in use in any state that have been identified and discussed for commercial and residential building appliances.

Table 23: Comparison of Stringency – Commercial and Residential Building Appliances

CARB Control Program Compared to Federal Standards and Control Programs in Other States

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Commercial and Residential Building Appliances			
Space and Water Heaters			
Emission standard (new sales): Zero-Emission Standard for Space and Water Heaters	Future measure: Zero-emission Standard for Space and Water Heaters (CARB)	CARB's Zero-Emission Standard for Space and Water Heaters measure is the most stringent standard of its type at the state level. This measure would reduce emissions from new residential and commercial space and water heaters sold in California. CARB would set an emission standard for space and water heaters to go into effect in 2030. CARB would adopt a statewide zero-emission standard which would have criteria pollutant benefits as a key result along with GHG reductions. Beginning in 2030, 100 percent of sales of new space heaters and water heaters would need to comply with the emission standard. *(Note: CARB has committed to pursue the Zero-Emission Standard for Space and Water Heaters measure, but this measure has not yet been proposed to the Board for approval/adoption)*	No other state has emission standards that require space and water heaters sales to be exclusively zero-emission by 2030. Maryland passed the Climate Solutions Now Act, establishing Building Energy Performance Standards for buildings 35,000 square feet and larger to achieve a 20 percent reduction in net direct greenhouse gas (GHG) emissions by 2030 and net-zero emissions by 2040. The regulation also requires holistic retrofits of low-income households, including weatherization and heat pump installations.[128] New York supports statewide building decarbonization in new construction and existing buildings through a combination of building codes and appliance efficiency standards, among other strategies.[129]

[128] Maryland Department of Environment. "Building Energy Performance Standards: Summary of Authorizing Law for the Development of Regulations." Accessed on April 13, 2023 at: https://mde.maryland.gov/programs/air/ClimateChange/Pages/BEPS.aspx.

[129] New York State Energy Research and Development Authority. 2022. "New York's Carbon Neutral Buildings Roadmap." Available at: https://www.nyserda.ny.gov/All-Programs/Carbon-Neutral-Buildings.

While there may be certain local jurisdictions with requirements for zero-emission space and water heaters that establish earlier implementation dates, CARB has analyzed other State-level requirements and must evaluate feasibility for implementation on a statewide level. As shown in Table 24 above, CARB's Zero-Emission Standard for Space and Water Heaters measure is the most stringent State-level requirement of its type within the U.S.

STEP 3(A): EVALUATION OF STRINGENCY: COMMERCIAL AND RESIDENTIAL BUILDING APPLIANCES CONTROL MEASURES

CARB has committed to bringing to the Board by 2025 a measure for zero-emission commercial and residential building appliances, which would propose to require, beginning in 2030, that 100 percent of new space and water heaters sold in California meet the zero-emission standard. No other state is engaged in more stringent efforts to require zero-emission space and water heaters.

Furthermore, CARB staff have conducted an analysis of the timing of the new space and water heater measure included in the 2022 State SIP Strategy. This measure is still in its development phase and is not yet being implemented; the development timeline, however, is critical to allow industry sufficient time to implement the requisite changes in their business models to transition to exclusively selling the required zero-emission technologies called for in this proposed regulatory action, and for manufacturers to scale up production to levels sufficient to meet the demand stimulated by a statewide requirement: A more expedited timeframe would be neither technologically nor economically feasible.

The public process to undertake a rulemaking of this scope would be at least two years. Additionally, manufacturers need time to ramp up production of zero-emission technologies to meet the expected demand. For example, despite the fact that appliance saturation studies in California show residential electric use for space heating has quadrupled over the last 10 years, manufacturing and deployment would need to continue to accelerate to meet the demand under a new zero-emission space and water heater standard.[130] Further, CARB would need to design any such standard in collaboration with energy regulators (U.S. Department of Energy and California Energy Commission), and building code regulators (California Building Standards Commission, California Department of Housing and Community Development, and California Energy Commission), and with air districts, ensure it was consistent with all State and local efforts, and would work carefully with communities to consider any housing cost or affordability impacts, recognizing that reducing emissions from space and water heaters can generate health benefits and cost-savings with properly designed standards.

CARB understands that this measure needs to be part of a suite of equity-promoting and complementary building decarbonization policies deeply informed by public process that include scaling back natural gas infrastructure, expanding construction of zero-emission buildings, and building a sustainable market by increasing affordability and accessibility through expanding incentive programs, ensuring utility rates are supportive of electrification, developing the workforce, and increasing consumer education. As part of the public process for equity promoting building decarbonization, CARB is reviewing and considering reports like Building Energy, Energy and Power (BEEP) Coalition's

[130] Opinion Dynamics, *California Heat Pump Residential Market Characterization and Baseline Study*, Figure 18. May 17, 2022. Retrieved from: https://www.calmac.org/publications/OD-CPUC-Heat-Pump-Market-Study-Report-5-17-2022.pdf

Community Priorities for Equitable Building Decarbonization Equitable.[131] Community engagement will be a critical aspect of the entire public process. CARB needs to engage with community-based organizations and other key stakeholders to incorporate equitable considerations for low-income and environmental justice communities where feasible.

For these reasons, the Zero Emission Standard for Space and Water Heaters measure meets the MSM requirement of being phased in as "expeditiously as practicable".

[131] Building Energy, Equity and Power Coalition, *Community Priorities for Equitable Building Decarbonization.* March 1, 2022. Retrieved from: https://ww2.arb.ca.gov/sites/default/files/2022-03/BEEP%20Letter%20and%20Report_Equitable%20Decarb%20March%202022.pdf

Table 24: Commercial and Residential Building Appliances Control Measures – Stringency and Timeline for Implementation

Measures	Implementation Begins	12 ug/m3 Annual (2012)
State SIP Strategy Residential and Commercial Building Appliance Measures (with Commitment)		
Zero Emission Standard for Space and Water Heaters measure	2030	MSM
With the Zero-Emission Standard for Space and Water Heaters measure, CARB would set a statewide zero-emission standard for space and water heaters. Beginning in 2030, 100 percent of the sales of new space heaters and water heaters would need to comply with the emission standard. This standard would be the most stringent of any state in the U.S., and would exceed the stringency of Federal requirements; further increases in stringency are not feasible. New zero-emission standards take years of lead time to ensure manufacturers have sufficient time to implement the necessary changes in their business models and to scale up production to a sufficient level to meet the demand produced by a Statewide standard; a more accelerated timeline is not feasible		

STEP 3(B): EVALUATION OF FEASIBILITY: COMMERCIAL AND RESIDENTIAL BUILDING APPLIANCES CONTROL MEASURES

Step 3(b) calls for an assessment of the feasibility of implementing any measure that is not included in the proposed South Coast SIP, but which is identified as a potential MSM control measure in Step 2. Staff developed the Zero-Emission Standard for Space and Water Heaters measure in response to a public measure suggestion received during the public process for the 2022 State SIP Strategy, which is described below:

- Additional Building Emission Standards
  CARB could propose additional emissions standards for combustion sources used in buildings by working with air districts to set such standards and, with building and energy code agencies on standards for new construction, or by taking other actions (including potentially incentive programs) to accelerate the removal of fossil fuels from the building stock in both new and existing buildings.

  CARB staff has been investigating the feasibility and potential benefits of this suggested measure and have included in the 2022 State SIP Strategy the Zero-Emission Standard for Space and Water Heaters measure, which also includes the potential to include other end-uses.

CARB staff do not recommend eliminating any of the potential commercial and residential building appliance control measures identified on the basis of technical or economic infeasibility.

Summary of Steps 2 and 3

STEP 2: POTENTIAL MOBILE SOURCE CONTROL MEASURES IDENTIFIED

The purpose of Step 2 is to identify all potential MSM control measures for the emission sources identified Step 1. Per U.S. EPA guidance, staff began to identify the list of all potential MSM control measures by starting with California's control program (Step 2(a)), which includes:

- Control measures adopted in the SIP for the South Coast (i.e. the current control program); and
- Additional control measures committed to in the 2022 State SIP Strategy.

In Step 2(b), staff expanded the scope of focus beyond California's controls to identify any additional potential MSM control measures that are in use in other nonattainment areas and states, and which exceed the stringency of California's controls identified in Step 2(a). The analysis undertaken for Step 2(b) found that, while there are some measures in other jurisdictions that have emission controls which are individually more stringent than an individual CARB control program, the comprehensive stringency of similar control measures committed to in the 2022 State SIP Strategy meets and/or exceeds the stringency of the controls in use in other jurisdictions. Thus, Step 2(b) did not identify any additional potential MSM control measures in use in other jurisdictions that are more stringent than the California control measures previously identified in Step 2(a).

To meet statutory requirements for the MSM plans, staff also reviewed all previous South Coast PM2.5 SIPs in Step 2(c), and found no CARB mobile source control measures that were proposed in previous Moderate or Serious attainment plan control strategies for the area that were not subsequently adopted and/or implemented.

As there are no applicable control measures previously rejected as infeasible for the South Coast's MSM demonstration process, Step 2(c) did not identify any additional potential MSM control measures beyond the control measures identified in Steps 2(a) and 2(b).

STEP 3: ANALYSIS OF STRINGENCY AND FEASIBILITY

The analysis of stringency and feasibility for each possible MSM control measure identified in Step 2 has shown that California's control program is at least consistent with the most stringent of any nonattainment area or state in the nation, with the majority of California control measures exceeding the stringency of controls in use in the rest of the nation.

The control measures included in the proposed 2024 12 µg/m3 annual PM2.5 Plan represent the full suite of emission control approaches that aligns with the most stringent levels of control feasible, given the current status of technology and its potential in the near future. Furthermore, CARB staff has not received any public comments to date indicating that more stringent control technologies than those included in the proposed South Coast SIP would be commercially available and/or

technologically and economically feasible to implement in the timeframe required for the area's PM2.5 SIPs. The control measures analyzed in this document therefore meet the requirements of Most Stringent Measures (MSM).

Section V. Step 4: Adoption of Control Measures

The final step required by the Act's step-wise process is to adopt and implement feasible control measures identified in Step 3 to satisfy MSM requirements.

The CARB control program for the proposed South Coast 2024 12 µg/m3 annual PM2.5 Plan includes all of the measures identified as MSM in Step 3. The control measures included in this analysis have been shown to meet the MSM requirements. The control measures described in this chapter are in varying stages of the adoption and implementation process at CARB:

- Most of the measures identified as MSM have already been adopted by the Board, submitted into the SIP, and are currently being implemented as part of CARB's current control program.
- Additional control measures have been committed to in the 2022 State SIP Strategy, which the Board adopted in September 2022, yet many of these control measures themselves have not yet been adopted by the Board. The Board's adoption of the 2022 State SIP Strategy created a commitment to adopt measures according to a defined schedule, and a commitment to achieve specified emission reductions in the South Coast.

Board adoption of the proposed South Coast 2024 12 µg/m3 annual PM2.5 Plan – including the control measures described in the 2022 State SIP Strategy – will satisfy the requirements of Step 4.

Section VI. Conclusion: Findings of MSM Analysis

California's long history of comprehensive and innovative emissions control has resulted in the strongest mobile source control program in the nation. U.S. EPA has acknowledged the strength of these programs in their approval of CARB's regulations and through the waiver and authorization process. In addition, U.S. EPA has provided past determinations that CARB's mobile source control programs meet Best Available Control Measure (BACM) requirements, which are more stringent than RACM, as part of their 2019 approval of the South Coast's 24-hour PM2.5 Plan[132]:

> "Overall, we believe that the program developed and administered by CARB and SCAG provide for the implementation of BACM for PM2.5 and PM2.5 precursors in the South Coast nonattainment area."

Additionally, in their 2020 proposed approval of the San Joaquin Valley's PM2.5 Serious Area 2018 Plan,[133] U.S. EPA further found that CARB's mobile source control program met the more stringent level of MSM. In their 2020 proposal for that plan, U.S. EPA found that,

> "CARB's programs constitute the most stringent emission control programs currently available for the mobile source and fuels categories, taking into account economic and technological feasibility."[134]

Since then, CARB has continued to enhance and accelerate reductions from our mobile source control programs through the implementation of more stringent engine emissions standards, in-use requirements, incentive funding, and other policies and initiatives as described in the preceding sections. These efforts not only ensure that all source sectors continue to achieve maximum emission reductions through implementation of the cleanest current technologies, but also promote the ongoing development of more advanced zero and near-zero technologies. As a result, California's mobile source control programs reflect the most stringent and feasible level of emissions control in the nation and fully meet the requirements for MSM.

Additionally, this analysis shows that CARB's control measures committed to in the 2022 State SIP Strategy for commercial and residential building appliances also meets the requirements of MSM.

As the requirements for MSM are inclusive of the requirements for BACM – and indeed, are more stringent than BACM requirements – this analysis shows that CARB's control

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[132] 83 FR 5923 https://www.federalregister.gov/documents/2018/02/12/2018-02677/air-quality-state-implementation-plans-approvals-and-promulgations-california-south-coast-moderate

[133] 85 FR 44192 https://www.federalregister.gov/documents/2020/07/22/2020-14471/clean-air-plans-2006-fine-particulate-matter-nonattainment-area-requirements-san-joaquin-valley While elements of this plan were later disapproved and remanded due to a 9th Circuit Court of Appeals decision, the Court's findings nonetheless upheld EPA's approval of mobile source control measure finding of MSM.

[134] 85 FR 17382 https://www.federalregister.gov/documents/2020/03/27/2020-05914/clean-air-plans-2006-fine-particulate-matter-nonattainment-area-requirements-san-joaquin-valley

measures for mobile sources and for commercial and residential building appliances also meet the requirements of BACM, in addition to MSM.

In conclusion, CARB followed the procedures outlined by U.S. EPA for determining MSM, and have found that California's control programs for mobile sources and commercial and residential building appliances satisfy the applicable requirements for the PM2.5 standard in this analysis.

South Coast Air Basin Attainment Plan for the 2012 Annual PM2.5 Standard

Appendix III

ATTACHMENT C: QUANTITATIVE ANALYSIS FOR WOOD BURNING CURTAILMENT THRESHOLD

Emission Reduction Analysis for Rule 445 in Comparison to San Joaquin Valley Rule 4901

Summary

Rule 445 on Wood-Burning Devices establishes mandatory burning curtailment across the entire South Coast Air Basin (Basin) when daily PM2.5 concentration in any source receptor area (SRA) is projected to exceed 29 µg/m^3. Residences located 3,000 or more feet above mean sea level and low-income households are exempt from this curtailment. The emission reductions associated with this Basin-wide approach are compared to the potential emission reductions that would be achieved if San Joaquin Valley Air Pollution Control District's (SJVAPCD) Rule 4901 were to be applied to the Basin.

Rule 4901 Structure and Its Application to the South Coast Air Basin

SJVAPCD Rule 4901 establishes a tier system for emission curtailment that is based on whether devices are U.S. EPA certified (See Table III-C-1). Rule 4901 includes a registration procedure where household can register certified devices, which provides data on the penetration of certified devices within the San Joaquin Valley. In contrast, the Basin does not have implemented any registration system, and as a result, there is no reliable information on the percentage of households that use certified devices. And most of wood burning devices exist in the Basin are fireplaces used for ambience, not for heating or cooking. For simplicity and conservative approach, this analysis assumed that all wood burning devices are uncertified and subject to the most stringent thresholds: 20 µg/m^3 in non-hotspot areas, and 12 µg/m^3 for hotspot areas.

TABLE III-C-1
SAN JOAQUIN VALLEY'S RULE 4901 TIER STRUCTURE FOR EMISSIONS CURTAILMENT

	Certified Devices		Uncertified Devices & Fireplaces	
	Non-Hotspot	Hotspot	Non-Hotspot	Hotspot
Level 1	N/A	N/A	20 µg/m^3	12 µg/m^3
Level 2	65 µg/m^3	35 µg/m^3	20 µg/m^3	12 µg/m^3

Identifying Hotspots in the South Coast Air Basin

The quantitative analysis presented in this section utilizes SRAs as the geographical unit to delineate hotspots and non-hotspots. SJVAPCD Rule 4901 establishes hotspots and non-hotspots across nine forecast areas. Each county is considered a single forecast area, with the exception of Tulare County,

which is divided into two separate areas. Total population of the SJVAPCD jurisdiction is 4.2 million, which leads to an average of 0.47 million people per forecast area. The air quality forecast for the Basin is partitioned into 35 SRAs. Air quality forecast including PM2.5 is issued every day, tailored to individual SRA. The average population of an SRA is approximately 0.49 million, exceeding the population density of each forecast area in the San Joaquin Valley. According to the latest demographic data from SCAG's regional transportation plan, the Basin accommodates approximately 17.3 million residents. In addition, Rule 445 used to implement residential wood burning curtailment program by SRA until May 2020 when it was amended to incorporate contingency measure components to comply with PM2.5 and ozone SIP requirements. While SRA is a smaller area than a county, transport and dispersion are embedded in the South Coast AQMD's daily forecast system. The air quality forecast reflects emissions, meteorological conditions, topography, photochemistry, and transport, given that these pieces of information are reflected in the measurements and photochemical models of which results are input to the daily forecast system. A hotspot is defined as an SRA where the design value projected for the 2030 baseline exceeds 12 $\mu g/m^3$. This is consistent with the approach adopted by SJVAPCD, which defined hotspots as the forecast areas that exceed the annual PM2.5 standard after "incorporating an exhaustive list of aggressive potential measures in (San Joaquin) Valley wide."[1] The 2030 baseline design values employed in this analysis align with those utilized in the modeling results presented in Chapter 5. Spatial interpolation methods, identical to those applied in the unmonitored area analysis, were employed to assign design values for SRAs lacking valid measurement-based data. The unmonitored area analysis utilizes inverse distance weighting with model gradient adjustment. The resulting SRAs classified as hotspots are illustrated in Figure III-C-1.

[1] Adoption of proposed amendments to San Joaquin Valley Air Pollution Control District's Rule 4901, June 2019. https://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2019/June/final/13.pdf

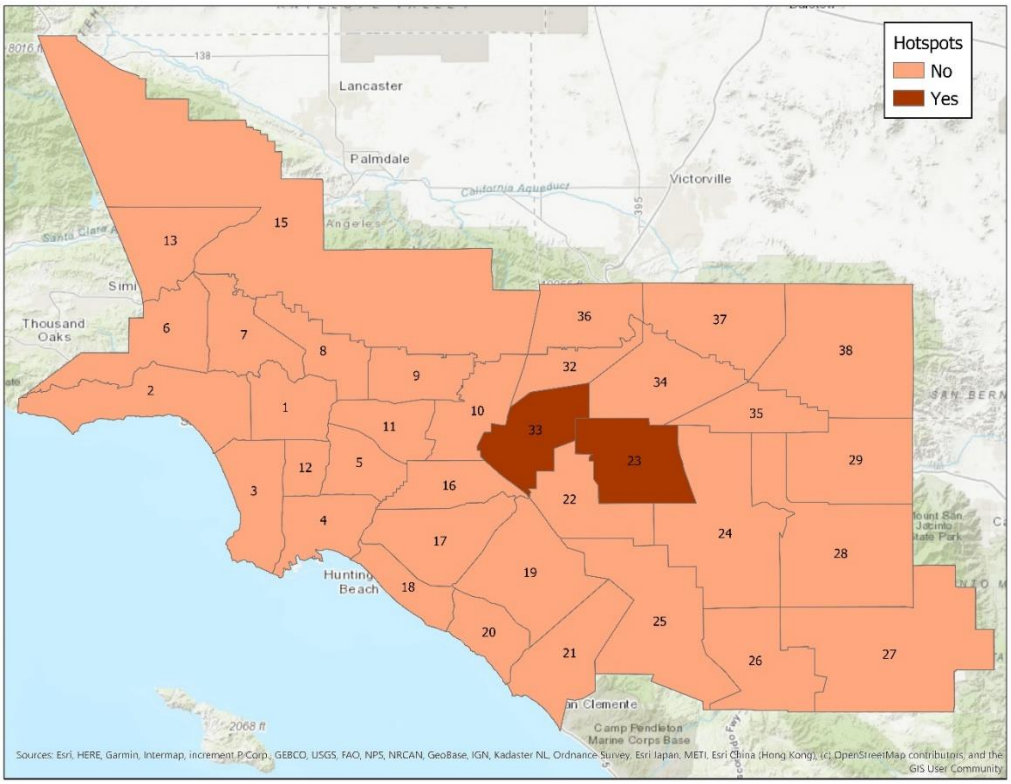

FIGURE III-C-1
HOTSPOT AND NON-HOTSPOT SOURCE RECEPTOR AREAS (SRAS)

Quantification of Emission Reductions

Emission reductions due to curtailment are quantified using the following procedure:

1) Determine the monthly emissions:

Emissions by SRA are determined by spatially allocating county-wide emissions from residential wood combustion with the spatial surrogate factors employed in air quality modeling. The spatial allocation factors are available at 1 km grid spacing. The emissions were allocated to each month based on levoglucosan measurements. These monthly allocation factors were utilized in the October 2020 amendment of the Rule 445,[2] the current version of the rule. The total emissions subject to Rule 445 are shown by area in Table III-C-2. The emissions are estimated with no curtailment in place. For the basin-wide emissions, the total excludes emissions above 3,000 feet to account for the exemption included in Rule 445. In contrast, emissions by SRA include all emissions without any exemption related to altitude because such exemption is not included in SJVAPCD Rule 4901.

[2] Staff report for the amendment to Rule 445, approved in October 2020. Available at: https://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2020/2020-oct27-001.pdf

TABLE III-C-2
EMISSIONS FROM RESIDENTIAL WOOD COMBUSTION BY AREA WITHOUT ANY CURTAILMENT

	Emissions (tons/month)			
SRA	January	February	November	December
Basin total*	330.8	214.0	350.2	583.7
1	14.9	9.6	15.8	26.3
2	15.4	10.0	16.3	27.2
3	20.4	13.2	21.6	36.0
4	14.7	9.5	15.5	25.9
5	13.6	8.8	14.4	24.0
6	15.6	10.1	16.5	27.5
7	15.2	9.8	16.1	26.8
8	6.6	4.3	7.0	11.6
9	11.5	7.5	12.2	20.4
10	9.4	6.1	9.9	16.6
11	10.8	7.0	11.5	19.1
12	7.6	4.9	8.0	13.4
13	4.4	2.9	4.7	7.8
15	7.7	5.0	8.1	13.5
16	9.4	6.1	9.9	16.5
17	19.1	12.4	20.2	33.7
18	12.0	7.8	12.7	21.2
19	7.7	5.0	8.1	13.5
20	4.3	2.8	4.5	7.5
21	2.9	1.9	3.1	5.2
22	10.0	6.5	10.6	17.7
23	12.6	8.2	13.4	22.3
24	12.9	8.3	13.6	22.7
25	5.8	3.7	6.1	10.2
26	11.6	7.5	12.3	20.5
27	0.3	0.2	0.3	0.4
28	5.9	3.8	6.2	10.3
29	2.8	1.8	3.0	5.0
32	11.4	7.4	12.1	20.1
33	13.8	8.9	14.6	24.3
34	19.5	12.6	20.6	34.3
35	6.1	4.0	6.5	10.8
36	0.1	0.1	0.1	0.2
37	3.9	2.5	4.1	6.9
38	4.3	2.8	4.6	7.6

* Basin total excludes emissions located above 3,000 feet.

2) Determine the number of ("no-burn") days exceeding varying thresholds:

Air quality data recorded in the period from 2019 through 2023 is processed using a retrospective archive of PM2.5 values from South Coast AQMD's AQI mapping system. This system is run in real-time to report hourly values of PM2.5, PM10, O3, NO2, CO, and AQI on the South Coast AQMD website (www.aqmd.gov) and on the South Coast AQMD mobile app (www.aqmd.gov/mobileapp). This peer-reviewed algorithm[3] blends data from regulatory monitors, low-cost sensors, and chemical transport model simulations of ozone and PM2.5 from the National Air Quality Forecast Capability. This map has been operational since November 2020, but staff conducted a reanalysis to recreate the gridded hourly values from 2019 through 20203. The hourly values were then aggregated into daily values for each 5 km by 5 km grid cell. The highest daily PM2.5 value of all the grid cells in each SRA was determined for everyday between 2019 to 2023. The number of days exceeding the thresholds of 12 µg/m^3 and 20 µg/m^3 in each SRA is provided in Table III-C-3. In comparison, the number of days exceeding a specific threshold anywhere in the basin – 12 µg/m^3, 20 µg/m^3, and varying from 25 µg/m^3 to 30 µg/m^3 – is presented in Table III-C-4. Hotspot areas in Mira Loma (SRA 23) and Ontario CA-60 Near-Road (SRA 33) exhibit high number of days exceeding thresholds. In contrast, non-hotspot SRAs, e.g., SRAs 26-29 and 37-38 exhibit a low number of curtailment days. Because the basin, as a whole, includes all the areas that may exceed a certain threshold, the basin-wide numbers are always higher than the exceeding days of any given SRA.

[3] Schulte N., Li X., Ghosh J. K., Fine P. M., Epstein S. A., 2020. Responsive high-resolution air quality index mapping using model, regulatory monitor, and sensor data in real-time. Environmental Research Letters, 15, 1040a7. DOI: 10.1088/1748-9326/abb62b

TABLE III-C-3
NUMBER OF CURTAILMENT DAYS THAT WOULD BE CALLED UNDER TWO THRESHOLDS: 12 µg/m³ AND 20 µg/m³

	Threshold = 12 µg/m³					Threshold = 20 µg/m³			
SRA	Jan	Feb	Nov	Dec		Jan	Feb	Nov	Dec
1	15	10	18	15		4	2	8	5
2	11	7	15	12		3	2	6	3
3	18	11	19	20		8	3	10	7
4	19	14	21	21		8	2	9	10
5	20	13	21	22		9	3	10	10
6	8	6	15	16		2	0	4	4
7	16	12	19	20		4	2	8	6
8	12	7	13	13		2	2	5	4
9	11	7	12	13		4	2	6	4
10	11	9	12	13		5	3	7	4
11	13	9	14	15		6	2	7	5
12	21	14	23	23		10	3	12	12
13	3	2	9	6		0	0	3	1
15	5	5	12	9		2	1	4	2
16	15	10	16	18		7	3	8	7
17	17	10	17	19		7	3	8	7
18	15	6	14	15		4	1	4	5
19	13	8	14	12		5	2	6	5
20	7	3	9	8		3	1	2	4
21	7	5	11	10		3	2	3	4
22	20	15	18	20		11	6	12	11
23	20	15	19	21		10	6	13	11
24	7	6	11	8		1	1	3	2
25	6	5	10	8		2	1	3	2
26	4	2	6	6		0	0	1	1
27	2	2	3	1		0	0	0	1
28	5	6	8	7		1	1	2	2
29	4	5	7	6		1	1	1	1
32	8	7	13	12		4	2	6	3
33	20	14	18	21		10	6	12	11
34	10	8	16	16		3	2	8	7
35	3	3	10	8		0	1	2	2
36	3	3	9	7		1	1	2	1
37	3	4	8	9		0	0	0	1
38	4	3	4	6		0	0	0	1

TABLE C-4
NUMBER OF CURTAILMENT DAYS IN THE BASIN THAT WOULD BE CALLED UNDER VARYING BASIN-WIDE THRESHOLDS

Threshold ($\mu g/m^3$)	January	February	November	December
12	26	20	27	27
20	15	9	16	16
25	10	5	11	10
26	9	4	10	10
27	8	4	10	9
28	7	3	9	9
29	7	3	8	8
30	6	2	8	7

3) Determine the curtailed emissions under SJVAPCD's Rule 4901 scenario in the South Coast Air Basin:

Emissions avoided by the curtailment are calculated by multiplying the number of days exceeding curtailment threshold by the emissions specified per month and geographical area. The curtailment thresholds are 12 $\mu g/m^3$ for hotspot SRAs and 20 $\mu g/m^3$ for non-hotspots SRAs. Emissions avoided for the period of November through February are shown in Table III-C-5. The total emission reductions resulting from this hotspot/non-hotspot scenario add up to 301 tons per year.

TABLE III-C-5
EMISSIONS REDUCTIONS BY SRA DUE TO CURTAILMENT USING 12 µg/m³ FOR HOTSPOT AND 20 µg/m³ FOR NON-HOTSPOT

SRA	Hotspot	Curtailed Emissions (tons/year)
1	No	11
2	No	8
3	No	22
4	No	17
5	No	17
6	No	7
7	No	12
8	No	3
9	No	7
10	No	7
11	No	8
12	No	11
13	No	1
15	No	3
16	No	9
17	No	19
18	No	7
19	No	5
20	No	2
21	No	1
22	No	15
23	Yes	36
24	No	4
25	No	2
26	No	1
27	No	0
28	No	1
29	No	0
32	No	6
33	Yes	39
34	No	16
35	No	1
36	No	0
37	No	0
38	No	0
Total		**301**

4) Compare emission reductions based on Rule 4901 approach to a Basin-wide curtailment approach:

The amount of emissions avoided due to Basin-wide curtailment was calculated by multiplying the number of exceeding days by the Basin-total emissions subject to Rule 445. Table III-C-6 presents the resulting curtailed emissions under various thresholds from 25 to 29 µg/m^3. The current Basin-wide curtailment threshold of 29 µg/m^3 already achieves higher emission reductions compared to SJVAPCD Rule 4901.

In addition, per U.S. EPA's recommendation, additional analysis was conducted to include the areas above 3,000 ft altitude. Since the high-altitude area accounts for less than 4 percent of the total wood burning emissions, even if the area is excluded, the curtailment threshold equivalent to the hotspot-based analysis would be still 29 µg/m^3.

TABLE III-C-6
EMISSION REDUCTIONS (IN TONS PER YEAR) UNDER VARIOUS BASIN-WIDE CURTAILMENT THRESHOLDS

	Threshold (µg/m^3)				
	25	26	27	28	29
Basin-wide Emission Reductions (tons/year)	462	432	402	372	342