

Chapter 3

BEST AVAILABLE CONTROL MEASURE (BACM) & MOST STRINGENT MEASURES (MSM) ANALYSIS OF CARB'S CONTROL PROGRAMS



This page intentionally blank.

TABLE OF CONTENTS

Executive Summary	3-1
3.1 Section I. Clean Air Act Requirements for Emission Control Measures.....	3-6
3.2 Section II. Process for Determining MSM.....	3-9
3.2.1 Step 1: Source Category Emissions of Direct PM _{2.5} and NO _x	3-12
3.2.2 Steps 2 and 3: Identification and Evaluation of Potential MSM Control Measures	3-12
3.2.3 Step 4: Adopt and Implement Feasible Control Measures.....	3-19
3.3 Section III. Step 1: Emissions of Direct PM _{2.5} and NO _x	3-20
3.4 Section IV. Steps 2 and 3: Identification and Evaluation of Potential Control Measures.....	3-22
3.4.1 On-Road Light-Duty Vehicles	3-25
3.4.2 On-Road Medium- and Heavy-Duty Vehicles	3-51
3.4.3 Off-Road Sources	3-103
3.4.4 Commercial and Residential Building Appliances	3-159
3.4.5 Summary of Steps 2 and 3	3-167
3.5 Section V. Step 4: Adoption of Control Measures.....	3-169
3.6 Section VI. Conclusion: Findings of MSM Analysis	3-170

TABLE OF FIGURES

Figure 3-1 Transition from Combustion	3-3
Figure 3-2 Process for Determining MSM	3-9
Figure 3-3 Light-Duty Control Measures	3-26
Figure 3-4 Heavy-Duty Control Measures	3-52
Figure 3-5 Off-Road Control Measures	3-104

TABLE OF TABLES

Table 3-1 Stringency of Control Measures Required.....	3-7
Table 3-2 MSM Requirements	3-11
Table 3-3 Implementation and Timing Requirements for MSM	3-17
Table 3-4 NO _x Emissions (tpd) from Mobile Sources in the Valley	3-20
Table 3-5 Direct PM _{2.5} Emissions (tpd) from Mobile Sources in the Valley.....	3-20
Table 3-6 NO _x and Direct PM _{2.5} Emissions (tpd) from Space and Water Heaters in the Valley	3-21
Table 3-7 Comparison of Stringency – Light-Duty Measures CARB Control Programs Compared to Federal Standards and Control Programs in Other States and Nonattainment Areas	3-37
Table 3-8 ACC I Section 177 States: LD Emission Standards and ZEV Regulation .	3-42
Table 3-9 Boutique Gasoline Fuel Programs in the U.S.....	3-46

Table 3-10	Light-Duty Control Measures Stringency and Timeline for Implementation..	3-48
Table 3-11	Adopted California and Federal Heavy-Duty Engine Emission Standards (for compression-ignition engines, shown in g/bhp-hr)	3-54
Table 3-12	Useful Life Periods	3-59
Table 3-13	Warranty Periods	3-59
Table 3-14	Allowable Levels of Smoke Opacity	3-62
Table 3-15	ZEB Purchase Schedule (ZEB Percentage of Total New Bus Purchases)..	3-71
Table 3-16	Zero-Emission Airport Shuttle Regulation Requirements	3-72
Table 3-17	Comparison of Stringency – Heavy-Duty Measures CARB Control Programs Compared to Federal Standards and Control Programs in Other States and Nonattainment Areas.....	3-75
Table 3-18	Medium- and Heavy-Duty Control Measures – Stringency and Timeline for Implementation	3-96
Table 3-19	Phase-in of Off-Road Engine Standards	3-104
Table 3-20	Comparison of Stringency – Off-Road Measures CARB Control Programs Compared to Federal Standards and Control Programs in Other States and Nonattainment Areas.....	3-129
Table 3-21	Off-Road Control Measures – Stringency and Timeline for Implementation.	3-152
Table 3-22	Comparison of Stringency – Commercial and Residential Building Appliances CARB Control Program Compared to Federal Standards and Control Programs in Other States.....	3-161
Table 3-23	Commercial and Residential Building Appliances Control Measures – Stringency and Timeline for Implementation	3-165

Chapter 3: Best Available Control Measure (BACM) and Most Stringent Measures (MSM) Analysis of CARB's Control Programs

[This section provided by California Air Resources Board]

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 PM_{2.5} standard. Effective December 27, 2021, the U.S. Environmental Protection Agency (U.S. EPA) classified the San Joaquin Valley (SJV or Valley) as a Serious nonattainment area for the 12 µg/m³ annual PM_{2.5} standard. As a consequence of U.S. EPA's reclassification of the SJV as a Serious nonattainment area, California is required to submit, within 18 months after the effective date of the reclassification, June 27, 2023, provisions to assure that Best Available Control Measures (BACM) shall be implemented no later than four years after the date of reclassification.

To satisfy this requirement, the State has conducted this analysis for each State-regulated source category emitting direct PM_{2.5} and relevant precursors in the Valley. Since the Valley may need an attainment date extension, the California Air Resources Board (CARB or Board) staff also analyzed these sources in context to the Most Stringent Measure (MSM) control requirements acknowledging that CARB has unique authority to control mobile sources beyond federal requirements. The suite of control measures that is currently being implemented by CARB or Board – both the current control program and new measures proposed for the Valley – satisfy the applicable BACM and MSM control requirements for the 12 µg/m³ annual PM_{2.5} standard for the Valley. 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 PM_{2.5} 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 Valley's upcoming SIP for the 12 µg/m³ annual PM_{2.5} standard.

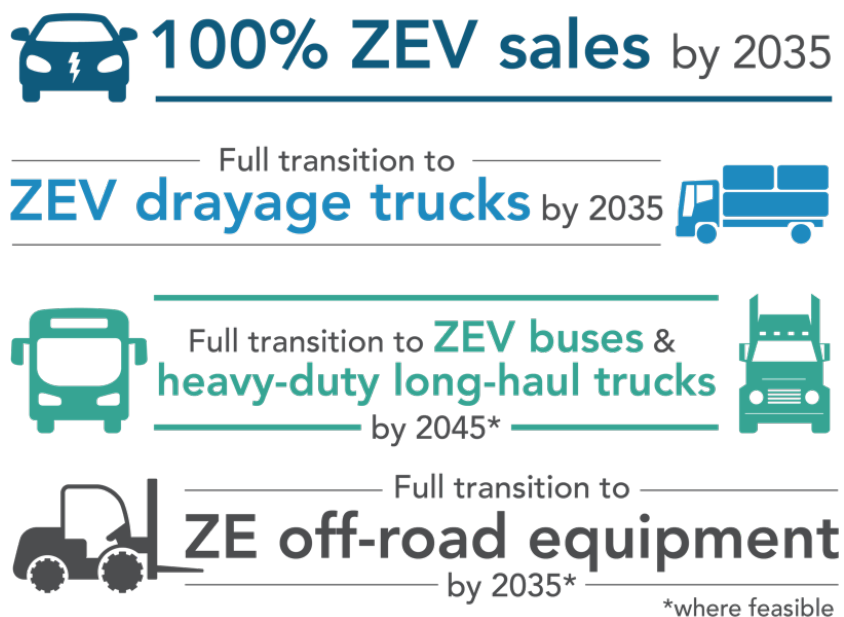
Given the severity of California's air quality challenges and the need for ongoing emission reductions, CARB has implemented the most comprehensive mobile source emissions control program in the nation. In aggregate, California's comprehensive suite of new vehicle and engine emission standards, in-use 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;
- 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-79-20².

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

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>

Figure 3-1 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 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 District 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 Valley'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 Valley'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 Valley'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.

3.1 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 PM_{2.5} 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 PM_{2.5} standard:

- For a Moderate nonattainment area, the required level of control is Reasonably Available Control Measures (RACM).³
- For a Serious PM_{2.5} 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 PM_{2.5} 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 PM_{2.5} 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

³ RACM requirements are addressed in the Moderate SIP for the Valley. For further information see <https://ww2.arb.ca.gov/our-work/programs/california-state-implementation-plans/nonattainment-area-plans/san-joaquin-valley>

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)

The Valley is a Serious nonattainment area for its upcoming SIP for the 12 $\mu\text{g}/\text{m}^3$ annual PM_{2.5} standard discussed in this plan and will include an extension beyond ten years.

REQUIRED STRINGENCY OF CONTROL MEASURES

Based on the Valley's current classification for 12 $\mu\text{g}/\text{m}^3$ annual PM_{2.5} standard, Table 3-1 describes the level of control measures required. The Valley's control measures for this plan must satisfy U.S. EPA's increasingly stringent Most Stringent Measures (MSM) requirements.

Table 3-1 Stringency of Control Measures Required⁸

Standard	Classification	Type of Plan	Control Measure Requirements
12 $\mu\text{g}/\text{m}^3$ Annual (2012 Standard)	Serious with Extension	Most Stringent Measures (MSM)	<p>Most Stringent Measures</p> <p>"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)</p>

DEFINING MOST STRINGENT MEASURES

MSM is the level of stringency required for the 2012 Annual Standards of 12 $\mu\text{g}/\text{m}^3$. The Act defines MSM as, "any permanent and enforceable control measure that achieves the most stringent emissions reductions in direct PM_{2.5} emissions and/or emissions of PM_{2.5} 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 PM_{2.5} 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 PM_{2.5} nonattainment area to Serious and that generally can achieve greater permanent and enforceable emissions reductions in direct PM_{2.5} emissions and/or emissions of PM_{2.5} plan precursors from

⁸ The Valley's SIP has been developed to provide the necessary elements for the for the 12 $\mu\text{g}/\text{m}^3$ Annual PM_{2.5} Standard, for which the Valley 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 Valley's SIP for the 12 $\mu\text{g}/\text{m}^3$ Annual PM_{2.5} Standard satisfy U.S. EPA's requirements for Serious area 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>

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;
- 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

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

¹³ 42 U.S. Code § 7479 – Definitions <https://www.gpo.gov/fdsys/pkg/USCODE-2011-title42/html/USCODE-2011-title42-chap85-subchapl-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>

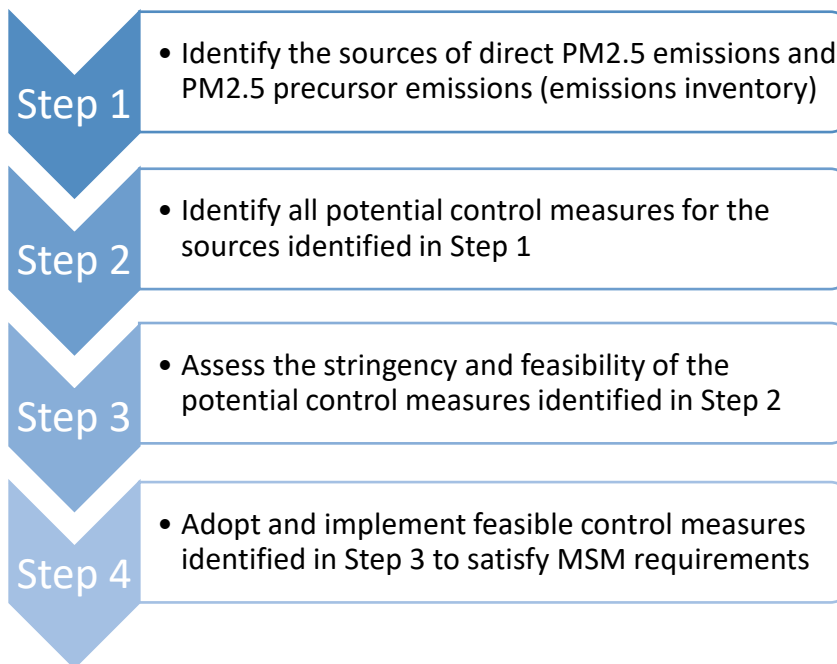
¹⁶ U.S. EPA 1994. *Addendum to the General Preamble*, 59 FR 41998 page 42010

3.2 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 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 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 3-2 Process for Determining MSM



This process starts with identifying the sources of PM_{2.5} 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 Valley.

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 3-2 delves more deeply into this process, showing each required element in the steps listed above for both of the applicable PM2.5 Standards.

Table 3-2 MSM Requirements

Standard	12 µg/m ³ Annual PM _{2.5} Standard (2012)
Classification	Serious with Extension
Control Strategy	MSM
<u>Step 1:</u> Identify sources of direct PM _{2.5} and precursor emissions (emissions inventory)	Required "The state shall identify all sources of direct PM _{2.5} emissions and sources of emissions of PM _{2.5} precursors in the nonattainment area in accordance with the emissions inventory requirements..." § 51.1010(b)(1)
<u>Step 2:</u> Identify all potential control measures	Required "The State shall identify all potential control measures to reduce emissions from all sources of direct PM _{2.5} emissions and sources of emissions of PM _{2.5} plan precursors" § 51.1010(b)(2)
<u>Step 2(a):</u> 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"
<u>Step 2(b):</u> Survey other states and nonattainment areas for additional potential control measures	Required "The state shall identify the most stringent measures for reducing direct PM _{2.5} and PM _{2.5} plan precursors adopted into any SIP or used in practice to control emissions in any state" § 51.1010(b)(2)(i)
<u>Step 2(c):</u> 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)
<u>Step 3:</u> Assess potential control measures' stringency and feasibility	Required
<u>Step 3(a):</u> Evaluate stringency	Required MSM control levels required
<u>Step 3(b):</u> 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
<u>Step 4:</u> 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>

3.2.1 Step 1: Source Category Emissions of Direct PM_{2.5} and NO_x

The first step required in the MSM evaluation process is to identify and quantify the sources of PM_{2.5}, including direct PM_{2.5} emissions and emissions of precursor pollutants.

In the Valley, 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 PM_{2.5} levels. Overall, mobile sources contribute to approximately 40 to 50 percent of the particles that make up PM_{2.5} in the Valley. These contributions come through both directly emitted PM_{2.5} and gaseous precursors such as NO_x, the key precursor to atmospheric formation of PM_{2.5} in the Valley. CARB modeling demonstrated that VOC, ammonia, and SO_x do not contribute significantly to ambient PM_{2.5} levels exceeding the NAAQS.

Residential and commercial buildings in California are the source of about 66 tpd NO_x statewide due to natural gas combustion.²⁰ Nearly 90 percent of building NO_x 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 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.

3.2.2 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 PM_{2.5} and NO_x identified in Step 1.²¹ To satisfy the Act’s MSM requirements, this is a three-part process.

²⁰ CARB’s Criteria Emission Inventory CEPAM: 2019 Version - Standard Emission Too

²¹ In a departure from previous SIP guidance, EPA guidance indicates that are no *de minimis* source categories for this plan. Thus, emissions of direct PM_{2.5} and PM_{2.5} precursors (i.e. NO_x) from all mobile source categories must be controlled in the Valley, 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>

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.²²

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 Valley's proposed SIP.^{23, 24} The purpose is to identify whether there are additional potential MSM control measures used to control mobile emissions of direct PM_{2.5} and/or NO_x in other states or nonattainment areas that are more stringent than the measures included in the Valley's 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 Valley (see Step 3) – the Act requires that any such measures are adopted and implemented in the Valley's plan (see Step 4), in order to meet the requirements that the area, “attain the standard as expeditiously as practicable.”²⁵

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:²⁶

- 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);²⁷
- U.S. EPA's “Menu of Control Measures” for PM_{2.5}; ²⁸ and
- U.S. EPA's mobile-specific control measures for PM_{2.5}.²⁹

²² U.S. EPA “Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements” July 2016

²³ § 51.1010(a)(2)(i), § 51.1010(b)(2)(i), and § 51.1010(c)(2)(i)

²⁴ U.S. EPA “Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements” July 2016

²⁵ § 51.1010(b)(4) and § 51.1004(a)(3)

²⁶ 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>

²⁷ U.S. EPA <https://www.epa.gov/pm-pollution/epa-summaries-and-reports-several-state-and-local-pm-control-measures>. Accessed April 24, 2018

²⁸ 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>

²⁹ U.S. EPA <https://www.epa.gov/advance/control-measures-programs-pm>. Accessed April 24, 2018

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,"³⁰ 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 the Valley's proposed 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 Valley that were previously rejected as infeasible.³¹

CARB staff reviewed all previous Valley PM_{2.5} SIPs³² 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 Valley.

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. CARB also solicited additional public measure suggestions during the public process for the development of the 12 µg/m³ SIP for the San Joaquin Valley,

³⁰ 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.

³¹ 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)

³² See CARB's list of San Joaquin Valley Air Quality Management Plans at <https://www.arb.ca.gov/planning/sip/planarea/sanjqnvllsips.htm>

including at public workshops held on March 23, 2023, and on May 11, 2023, but did not receive additional suggestions to add to those previously identified during the 2022 State SIP Strategy process. 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.
- **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 Valley.

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 Valley.

[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."³³ Economic feasibility considerations include capital costs, operating and maintenance

³³ 40 CFR § 51.1010(a)(3)(i)

costs, and cost effectiveness of the measure.³⁴ 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 Valley'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".³⁵ In its proposed disapproval of the San Joaquin Valley's Serious plan for the 2012 12 $\mu\text{g}/\text{m}^3$ annual PM_{2.5} standards,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. For the PM_{2.5} standard discussed in this plan, Table 3-3 summarizes the required levels of control measures, and the required timeframe for implementation in order to meet the definition of MSM.

Table 3-3 Implementation and Timing Requirements for MSM

Standard	12 $\mu\text{g}/\text{m}^3$ Annual PM _{2.5} Standard (2012)
Classification Status	Serious with Extension
Type of Plan Required	MSM
Control Measure Requirements	MSM
Definition of MSM (regarding timing)	<u>MSM</u> : implemented in whole or in part by 5 years after the applicable attainment date for the area ³⁷
Attainment deadline	2030
Timeframe for Implementation	MSM if implemented \leq 2035

Comparing the Stringency of the Valley'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 Valley's plan satisfy the stringency definition for MSM is to compare the measures included in the Valley's plan against the measures already adopted in the Valley's SIP to determine if the existing control measures alone are more stringent.³⁸ CARB staff has compared the current control program to the control measures included in the Valley's plan, and has found that:

- The suite of control measures in the Valley's 12 $\mu\text{g}/\text{m}^3$ PM_{2.5} annual SIP 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 Valley's proposed SIP is more stringent than the existing control program alone because the plan encompasses both the

³⁴ 40 CFR § 51.1010(a)(3)(ii)

³⁵ 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>

³⁶ 87 FR 60494

³⁷ 40 CFR § 51.1010(b)(3)

³⁸ 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>

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 Valley 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.³⁹ 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, the Valley State 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 Air Quality Management District. 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.⁴⁰

Additionally, an economic impact analysis was conducted for the newly proposed measures that were committed to in the 2022 State SIP Strategy.⁴¹ 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 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

³⁹ 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.

⁴⁰ Technology and Fuel Assessments <http://www.arb.ca.gov/msprog/tech/tech.htm>

⁴¹ 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>

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.

3.2.3 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 Valley SIP for the 12 $\mu\text{g}/\text{m}^3$ annual PM_{2.5} standard – including the control measures described in the 2022 State SIP Strategy – will satisfy the requirements of Step 4.

3.3 SECTION III. STEP 1: EMISSIONS OF DIRECT PM2.5 AND NOX

Tables 3-4, 3-5, and 3-6 show the emissions of direct PM2.5 and NOx, the key precursor to secondary formation of PM2.5 in the Valley.⁴² It is important to note that, as this is an assessment of CARB's control measures for mobile sources and space and water heaters, these tables reflect only a subset of the total emissions in the Valley, and do not reflect emissions from stationary and areawide sources.

Table 3-4 NOx Emissions (tpd) from Mobile Sources in the Valley

	2017	2030
On-Road Light-Duty Vehicles	13.7	4.1
On-Road Heavy-Duty Vehicles	84.4	16.6
Off-Road Federal and International Sources	15.7	21.2
Aircraft	2.5	4.6
Railroad	13.1	16.5
Off-Road Equipment	83.9	38.0
Total NOx from Mobile Sources	197.7	79.8

*Numbers may not add up due to rounding.

Table 3-5 Direct PM2.5 Emissions (tpd) from Mobile Sources in the Valley

	2017	2030
On-Road Light-Duty Vehicles	1.2	1.3
On-Road Heavy-Duty Vehicles	3.7	2.3
Off-Road Federal and International Sources	1.6	2.1
Aircraft	1.3	1.8
Railroad	0.3	0.4
Off-Road Equipment	4.8	2.2
Total Direct PM2.5 from Mobile Sources	11.3	7.9

*Numbers may not add up due to rounding.

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 oxides of nitrogen (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. The emissions for those source categories are shown in Table 3-6 below.

⁴² Data from CEPAM 2016 Ozone SIP Version 1.05 with external adjustments
<http://outapp.arb.ca.gov/cefs/2016ozsip/index.php>

Table 3-6 NOx and Direct PM2.5 Emissions (tpd) from Space and Water Heaters in the Valley

	NOx		PM	
	2017	2030	2017	2030
Residential Space Heating	1.5	1.1	0.2	0.2
Residential Water Heating	0.9	0.8	0.2	0.2
Commercial Space Heating	1.0	0.7	0.1	0.1
Commercial Water Heating	0.6	0.7	0.1	0.1
Total: Space and Water Heater	4.0	3.2	0.5	0.6

3.4 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 Strategy⁴³ 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, the 2018 Valley 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

⁴³ 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>

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 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.”⁴⁴

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

⁴⁴ 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>

3.4.1 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.⁴⁵

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 San Joaquin Valley 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 70 percent by 2030.

Figure 3-3 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.⁴⁶

⁴⁵ 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/>

⁴⁶ 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>

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 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.⁴⁷ 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.⁴⁸ 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.

⁴⁷ VELOZ, February 2023 "Electric Vehicle Market Report, Q4 2022" <https://www.veloz.org/ev-market-report/>

⁴⁸ 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/>

In support of California's transition to zero-emission vehicles, in 2020, Governor Newsom signed Executive Order N 79 20,⁴⁹ 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 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-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

⁴⁹ Executive Order N-79-20 <https://www.gov.ca.gov/wp-content/uploads/2020/09/9.23.20-EO-N-79-20-Climate.pdf>

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 PM₁₀ 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 PM_{2.5} 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 PM_{2.5} 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 2016.⁵⁰

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.

⁵⁰ 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

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 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 2006.⁵¹ 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

⁵¹ <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

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), NO_x, 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.

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 NO_x 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 taking 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 San Joaquin Valley, 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 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.

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 NO_x 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 NO_x 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 San Joaquin Valley has been required since December 2002. **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 as ethanol, which also helps the gasoline burn more cleanly.

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

Table 3-7 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 3-7 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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 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: Zero-emission Requirements (passenger cars)	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). 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	15 states have adopted the ZEV requirements of ACC I under the provisions of Section 177:

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Light-Duty Vehicles			
	ACC II's ZEV Program (CARB) MY 2026 – 2035 (part of Advanced Clean Cars II program)	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	<ul style="list-style-type: none"> NY, MA, VT, ME, CT, RI, WA, OR, NJ, MD, CO, MN, NV, VA, and NM <p>Five other states have adopted the new ZEV standards from ACC2 under Section 177: MA, OR, WA, VT, and NY</p> <p>There are no comparable federal standards for sales of zero-emission vehicles.</p>
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: <i>On-Road Motorcycle New Emissions Standards (CARB)</i>	<p>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.</p> <p>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.</p> <p><i>(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)</i></p>	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)	<p>The Inspection / Maintenance (I/M) Program testing and in-use emission controls in the San Joaquin Valley 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.</p> <p>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</p>	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			
		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)	<p>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.</p> <p>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.</p>	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: <i>Enhanced Regional Emission Analysis in SIPs (CARB)</i>	<p>CARB is considering the following measures to further reduce ROG and NO_x emissions from on-road motor vehicles by reducing VMT:</p> <ul style="list-style-type: none"> • 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 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. <p><small>(Note: CARB has committed to pursue the Enhanced Regional Emission Analysis in SIPs measure, but this measure has yet to finalized)</small></p>	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 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 San Joaquin Valley) <ul style="list-style-type: none"> • 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 <ul style="list-style-type: none"> • 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.⁵² 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 3-8.

⁵² 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 3-8 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.⁵³ 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.⁵⁴ 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.⁵⁵

⁵³ CARB 2015 "On-Board Diagnostic II (OBD II) Systems - Fact Sheet / FAQs"

<https://www.arb.ca.gov/msprog/obdprog/obdfaq.htm>

⁵⁴ CARB 2009 https://www.arb.ca.gov/msprog/smogcheck/march09/transitioning_to_obd_only_im.pdf

⁵⁵ 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 Valley 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 San Joaquin Valley 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 only other Extreme nonattainment area for ozone in the country, the South Coast. 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.⁵⁶ 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.⁵⁷

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

⁵⁶ CARB 2009 https://www.arb.ca.gov/msprog/smogcheck/march09/transitioning_to_obd_only_im.pdf

⁵⁷ 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

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 complementarily.

Since 1995, U.S. EPA has required federal RFG to be used in the worst-polluted areas in the nation – including the Valley 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 NO_x 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 NO_x emissions under requirements in CaRFG Phase 3 that are not mirrored by comparably stringent controls on NO_x emissions under the federal RFG Phase 3 requirements. Relative to federal gasoline, CARB's reformulated gasoline program reduces NO_x 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,⁵⁸ which are listed below in Table 3-9 below. Table 3-9 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.

⁵⁸ U.S. EPA, 2017 https://19january2017snapshot.epa.gov/gasoline-standards/state-fuels_.html

Table 3-9 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 3-7 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 3-10, 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 3-10 Light-Duty Control Measures Stringency and Timeline for Implementation

Measures	Implementation Begins	12 µg/m ³ Annual PM _{2.5} 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 Valley's 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 Program⁵⁹ 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

⁵⁹ Bureau of Automotive Repair (BAR) Consumer Assistance Program <https://www.bar.ca.gov/consumer/consumer-assistance-program>

included as a measure in the 2022 State SIP Strategy. Nonetheless, the recently 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.

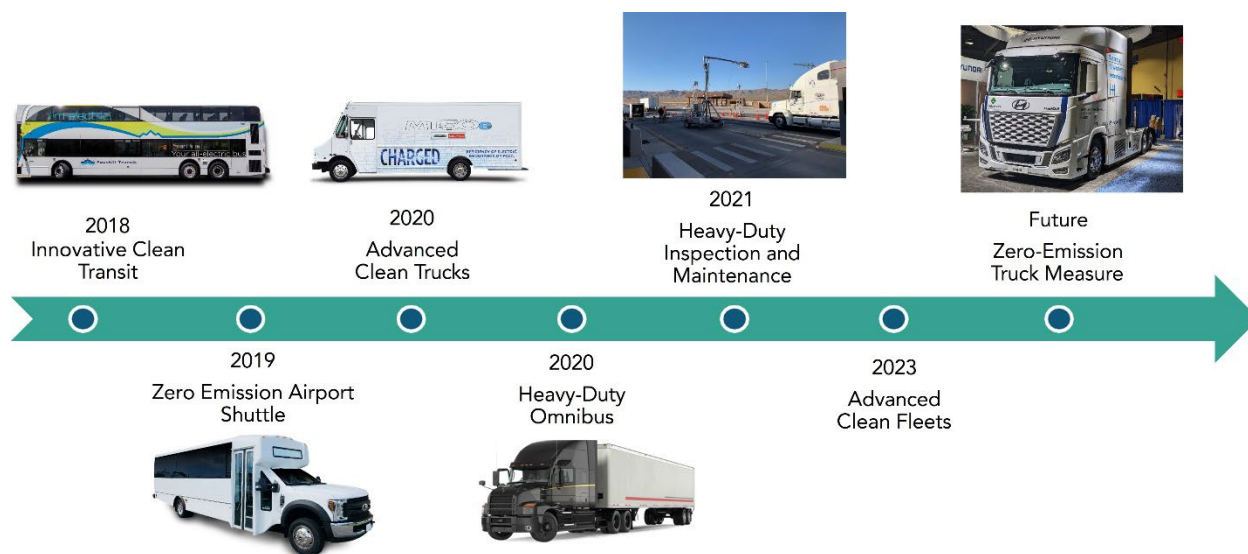
3.4.2 On-Road Medium- and Heavy-Duty Vehicles

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 NO_x 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 San Joaquin Valley from this source category have been reduced significantly since 1990, and will continue to decrease through 2030. From today, medium- and heavy-duty NO_x emissions are projected to decrease by over 80 percent in 2030, and emissions of direct PM are projected to decrease by nearly 39 percent in the same timeframe.

Figure 3-4 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 3-11, 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 \leq 435,000), and 0.035 (435,000 - 600,000 miles), and PM emission limits at 0.005 g/bhp-hr.

Table 3-11 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	0.20		0.01		0.01
		0.10 - 0.02 Optional					
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 NO_x emissions from heavy-duty engines by 90 percent without or with minimal GHG impacts. The results from these contracts referred to as the Stage 1,⁶⁰ Stage 2,⁶¹ and Stage 3⁶² Heavy-Duty Low NO_x 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 NO_x 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.⁶³

Optional heavy-duty engine emission standards

In addition to mandatory NO_x standards, CARB has also adopted several generations of **optional lower NO_x 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-NO_x emission standards.

- From 1998 to 2003, optional NO_x 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 NO_x + 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 NO_x+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 NO_x 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 NO_x emission

⁶⁰ SwRI, 2017. "Evaluating Technologies and Methods to Lower NO_x Emissions from Heavy-Duty Vehicles, Final Report" <https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/past/13-312.pdf>

⁶¹ 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-VDdXMF1hU2IAWQlw.pdf>

⁶² SwRI, 2021. "Further development and Validation of Technologies to Lower NO_x Emissions from Heavy-Duty Vehicles, Final Report" <https://www.arb.ca.gov/lists/com-attach/79-hdomnibus2020-Uj4AaQB2Aj8FbAhw.pdf>

⁶³ NREL, 2020. "On-Road Heavy-Duty Low-NO_x Technology Cost Study" <https://www.nrel.gov/docs/fy20osti/76571.pdf>

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 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 York, 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 will 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 3-12 Useful Life Periods and Table 3-13 Warranty Periods. The revisions would be phased-in beginning with the 2027 model year engines with the final phase-in occurring in 2031.

Table 3-12 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 3-13 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, known 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.⁶⁴

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

⁶⁴ 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>

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 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 PM_{2.5} 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 from 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 3-14 below.

Table 3-14 Allowable Levels of Smoke Opacity

Engines Equipped with a Diesel Particulate Filter (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 particulate matter 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 receipt, 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 2008.⁶⁵ 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 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

⁶⁵ 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>

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.⁶⁶

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 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

⁶⁶ 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

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;⁶⁷ 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.
- 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

⁶⁷ Large Entity Reporting <https://ww2.arb.ca.gov/our-work/programs/advanced-clean-trucks/large-entity-reporting>

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

The **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 PM_{2.5} 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. 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 NO_x 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 2013.⁶⁸ 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 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 San Joaquin Valley or the South Coast Air Basins 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

⁶⁸ 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>

- Reporting and record keeping requirements.

As shown in Table 3-15, 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 3-15 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 3-16. 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 3-16 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 CARB's 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 2035,⁶⁹ a mandate that was first introduced in New York Governor Kathy Hochul's 2022 State of the State Address.⁷⁰ 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.⁷¹

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 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

⁶⁹ New York Senate Bill S8006C <https://www.nysenate.gov/legislation/bills/2021/S8006>

⁷⁰ 2022 New York State of the State Book <https://info.aee.net/hubfs/2022StateoftheStateBookNY.pdf>

⁷¹ Rockefeller Institute of Government, November 2022 <https://rockinst.org/blog/meeting-new-yorks-electric-school-bus-mandate-takeaways-from-the-2022-school-finance-symposium/>

after-treatment, and other advanced after-treatment based emission control technologies that higher sulfur levels would have inhibited 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 3-17 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 3-17 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)	<p>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:</p> <ul style="list-style-type: none"> 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. 	<p>CARB is leading the nation on the development and penetration of on-road heavy-duty ZEVs through the Advanced Clean Trucks Regulation</p> <p>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.</p>
New Vehicle and Engine Standards: Heavy-duty internal combustion engine emission standards (mandatory standards)	<p>Mandatory Heavy-Duty vehicle and engine emission standards (CARB and U.S. EPA)</p> <p>Heavy-Duty Omnibus Regulation (CARB)</p>	<p>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.</p> <p>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.</p> <p>The limits are for MY 2024 - 2026:</p> <ul style="list-style-type: none"> NOx: 0.050 g/bhp-hr PM: 0.005 g/bhp-hr <p>For MY 2027-2030:</p>	<p>No other state has more stringent exhaust emission standards than California.</p> <p>Current CARB and U.S. EPA limit exhaust emissions to same levels (MY 2010 – 2023)</p> <ul style="list-style-type: none"> NOx: 0.20 g/bhp-hr PM: 0.01 g/bhp-hr <p>Five other States have also adopted the Omnibus regulation (MA, NY, OR, WA and VT).</p> <p>In MYs 2024-2026, California’s standards will exceed the stringency of Federal standards, which are currently at 0.20 g/bhp-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.</p>

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed														
On-Road Heavy-Duty Vehicles																	
		<ul style="list-style-type: none"> 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 <p>For 2031 and Subsequent MYs:</p> <ul style="list-style-type: none"> NOx : 0.020 g/bhp-hr @ miles ≤ 435,000 0.040 g/bhp-hr @ 435,000 < miles ≤ 800,000 PM: 0.005 /bhp-hr <p>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</p>															
New Vehicle and Engine Standards: Optional heavy-duty internal combustion engine emission standards	Optional Heavy-Duty Low NOx Emission Standards (CARB) Omnibus Regulation (CARB)	<p>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.</p> <p>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.</p>	California is the only state with optional exhaust emission standards for heavy-duty engines that exceed the stringency of U.S. EPA requirements.														
New Vehicle and Engine Standards: Warranty Requirements and Useful Life	California Emission Control System Warranty Regulations and Maintenance Provisions (CARB) Omnibus Regulation (CARB)	<p>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:</p> <ul style="list-style-type: none"> 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 <p>CARB Useful Life:</p> <table border="1"> <thead> <tr> <th rowspan="2">Model Year</th> <th colspan="4">Useful Life (miles)</th> </tr> <tr> <th>Class 4 – 5 Diesel</th> <th>Class 6 – 7 Diesel</th> <th>Class 8 Diesel</th> <th>Heavy-Duty Otto</th> </tr> </thead> <tbody> <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> </tbody> </table>	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	<p>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.</p> <p>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 requirements are at least as stringent as federal requirements for My 2027 – 2031+.</p>
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													

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis					Other Jurisdiction(s) Analyzed																				
On-Road Heavy-Duty Vehicles																											
		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																					
		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.)																									
New Vehicle and Engine Standards: OBD Requirements	Heavy-Duty OBD (CARB)	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.					No other state has more stringent OBD requirements than California																				
In-Use Emission Controls																											
In-Use Emissions Controls: I/M program (opacity limits)	Periodic Smoke Inspection Program (PSIP) (CARB)	<p>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).</p> <p>Allowable levels of Smoke Opacity are shown below:</p> <table border="1"> <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>					Engines Equipped with a Diesel Particulate Filter (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		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.
Engines Equipped with a Diesel Particulate Filter (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																											
In-Use Emissions Controls:	Heavy-Duty Vehicle Inspection Program (HDVIP) (CARB)	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					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																				

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
I/M program (Testing)	Periodic Smoke Inspection Program (PSIP) (CARB) The Heavy-Duty Omnibus Regulation (CARB) The Heavy-Duty Inspection and Maintenance Program (HD I/M) (CARB)	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 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.	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.
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: <ul style="list-style-type: none"> • 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: <ul style="list-style-type: none"> • 3 minute restrictions, some exemptions DE, Chicago (IL), NJ, Town of Mamaroneck (NY), and Rockland County (NY)
In-Use Emissions Controls:	Truck and Bus Regulation (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	No other state requires diesel particulate filters (DPF) and MY 2010 + equivalent engines as a mandatory

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
Fleet Rules	Advanced Clean Fleets Regulation (CARB) Future Measure: <i>Zero-Emission Trucks Measure (CARB)</i>	<p>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.</p> <p>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 regulation will phase in ZEV requirements for different fleets, including components as follows:</p> <ul style="list-style-type: none"> • 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. <p>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.</p> <p>The future Zero-Emission Trucks measure would accelerate the number of zero-emissions (ZE) trucks beyond existing measures (including the</p>	<p>fleet rule affecting nearly the entire on-road diesel fleet</p> <p>No other state has zero-emission requirements for heavy-duty vehicle fleets</p>

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
		<p>Advanced Clean Fleets regulation). This measure is anticipated to be implemented through one of two potential options:</p> <ul style="list-style-type: none"> 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. <p><i>(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)</i></p>	
<p>In-Use Emissions Controls: Fleet Rules (Drayage Trucks)</p>	<p>Truck and Bus Regulation (CARB)</p> <p>Advanced Clean Fleets Regulation (CARB)</p>	<p>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.</p> <p>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:</p> <ul style="list-style-type: none"> 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. 	<p>No other jurisdiction mandates more stringent fleet requirements for drayage trucks.</p>

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
<p>In-Use Emissions Controls: Fleet Rules (Solid Waste Collection Vehicles)</p>	<p>Solid Waste Collection Vehicle Regulations (CARB) Truck and Bus Regulation (CARB) Advanced Clean Fleets Regulation (CARB)</p>	<p>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.</p> <p>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 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.</p>	<p>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).</p>
<p>In-Use Emissions Controls: Fleet Rules (Public fleets)</p>	<p>Public Agency and Utility Regulation (CARB) Truck and Bus Regulation (CARB) Advanced Clean Fleets Regulation (CARB)</p>	<p>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.</p> <p>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.</p>	<p>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.</p>
<p>In-Use Emissions Controls: Fleet Rules (Transit fleets)</p>	<p>Transit Fleet Rule (CARB) Innovative Clean Transit Regulation (CARB)</p>	<p>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.</p>	<p>No other jurisdiction mandates more stringent fleet requirements for transit fleets.</p>

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
		<p>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.</p>	
<p>In-Use Emissions Controls: Fleet Rules (Last mile delivery trucks)</p>	<p>Truck and Bus Regulation (CARB) Advanced Clean Fleets Regulation (CARB)</p>	<p>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.</p> <p>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.</p>	<p>No other jurisdiction mandates more stringent fleet requirements for last mile delivery trucks.</p>
<p>In-Use Emissions Controls: Fleet Rules (Airport shuttle buses)</p>	<p>Truck and Bus Regulation (CARB) Zero-Emission Airport Shuttle Bus Regulation (CARB)</p>	<p>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.</p> <p>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.</p>	<p>No other jurisdiction mandates more stringent fleet requirements for airport shuttle buses.</p>
<p>In-Use Emissions Controls: Fleet Rules (School Buses)</p>	<p>Truck and Bus Regulation (CARB) School Bus Idling Airborne Toxic Control Measure (CARB) Omnibus Regulation (CARB) School Bus Incentive Program (CARB)</p>	<p>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.</p> <p>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.</p> <p>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,</p>	<p>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.</p> <p>CARB staff is unaware of any other jurisdictions that mandate retrofits.</p> <p>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.</p>

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
		<p>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.</p>	
Fuels Programs			
<p>Fuels Standards: Diesel Standards</p>	<p>CARB Diesel Fuel Regulations and Ultra Low Sulfur Diesel (CARB)</p> <p>Future Measure: <i>Low Emission Diesel measure (CARB)</i></p>	<p>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.</p> <p>CARB is anticipated to further increase the stringency of controls on criteria pollutant emissions diesel products. <i>(NOTE: CARB has committed to pursue the Low Emission Diesel measure, but it has not yet been proposed to the Board for approval/adoption.)</i></p>	<p>No state requires cleaner burning diesel than California. The California diesel fuel regulations exceed federal requirements in stringency.</p> <p>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.</p>
<p>Fuels Standards: Alternative Fuel Standards (Diesel substitutes)</p>	<p>Low Carbon Fuel Standard (CARB)</p> <p>Alternative Diesel Fuel Regulation (CARB)</p>	<p>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.</p>	<p>No other state has set as stringent of criteria emission requirements on alternative fuels and alternative fuel blends than California.</p> <p>For low carbon fuel/clean fuel programs:</p> <ul style="list-style-type: none"> • 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 PM_{2.5} at 0.01 g/bhp-hr and NO_x 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.⁷²

With the adoption and implementation of the Heavy-Duty Omnibus Regulation, CARB will further increase the stringency of these requirements to reduce NO_x 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 NO_x 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 NO_x 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 NO_x and 0.005 g/bhp-hr for PM. Like the California standards, the new federal standards will also require lower NO_x 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 San Joaquin Valley and other California nonattainment areas to meet U.S. EPA's air quality standards. However, U.S. EPA's recently finalized Low-NO_x rule 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.

⁷² U.S. EPA 2016 "Heavy-Duty Highway Compression-Ignition Engines and Urban Buses: Exhaust Emission Standards" <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockkey=P100Q9ZZ.pdf> accessed May 1, 2018.

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.⁷³ 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.⁷⁴ 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.⁷⁵ 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.⁷⁶ 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.⁷⁷

⁷³ 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>

⁷⁴ 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>

⁷⁵ U.S. EPA, 2022. “Heavy-Duty 2027 and Beyond: Clean Trucks Final Rulemaking” <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P101695R.pdf>

⁷⁶ ICCT 2021 <https://theicct.org/wp-content/uploads/2022/01/state-level-hdv-emissions-reg-FS-dec21.pdf>

⁷⁷ 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

[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 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 Valley 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](#)

2021 <https://www.sierraclub.org/press-releases/2021/12/governor-northam-signs-virginia-multi-state-agreement-electrify-trucks-and>

New Jersey has opacity limits that range from 40 percent to 20 percent.⁷⁸ 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 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.

⁷⁸ For more information on the New Jersey Opacity Limits, please see http://www.nj.gov/dep/bmvim/bmvim_emisStds.htm

Idling Requirements

The idling requirements in the Valley'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 2007.⁷⁹ 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

⁷⁹ <https://www.nytimes.com/2016/08/19/opinion/how-garbage-trucks-can-drive-a-green-future.html>

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 reduce PM_{2.5} 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 NO_x) 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.⁸⁰

New York State's enacted fiscal year 2022-2023 budget established a requirement for all new school buses purchased to be zero emission by 2027.⁸¹ Under the New York law, all school buses must be electric, including district-owned and leased vehicles upon full implementation in 2035.⁸² 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 2021.⁸³ 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 assessment of funding for home-to-school transportation conducted by the Legislative Analyst's Office in 2014,⁸⁴ 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.⁸⁵ 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

⁸⁰ CARB, 2022 <https://ww2.arb.ca.gov/news/new-report-shows-how-california-leading-nation-cleaning-school-buses>

⁸¹ New York Senate Bill S8006C <https://www.nysenate.gov/legislation/bills/2021/S8006>

⁸² Rockefeller Institute of Government, November 2022 <https://rockinst.org/blog/meeting-new-yorks-electric-school-bus-mandate-takeaways-from-the-2022-school-finance-symposium/>

⁸³ CARB, 2022 <https://ww2.arb.ca.gov/news/new-report-shows-how-california-leading-nation-cleaning-school-buses>

⁸⁴ Legislative Analyst's Office, 2014. "Review of School Transportation in California"

<https://lao.ca.gov/reports/2014/education/school-transportation/school-transportation-022514.pdf>

⁸⁵ CARB https://ww2.arb.ca.gov/sites/default/files/2022-10/fy2022_23_funding_plan_appendix_e.pdf

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.⁸⁶ 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,⁸⁷ the Low Emission Diesel Program in Texas (TxLED). The fuel specifications for the TxLED are based on CARB diesel requirements,⁸⁸ 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.⁸⁹ 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,⁹⁰ although U.S. EPA credited the TxLED program with providing approximately a 5 percent NOx emission reduction benefit over federal ULSD fuels.⁹¹ Furthermore, the stringency of Texas' testing requirements are based on the federal Complex Model, which is less

⁸⁶ 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.

⁸⁷ U.S. EPA, 2017 https://19january2017snapshot.epa.gov/gasoline-standards/state-fuels_.html

⁸⁸ 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

⁸⁹ Texas Commission on Environmental Quality

<https://www.tceq.texas.gov/assets/public/implementation/air/sip/texled/List%20of%20TCEQ-Approved%20Alternative%20Diesel%20Formulations.pdf>

⁹⁰ 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>

⁹¹ 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

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.

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 3-17 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 3-18, 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 3-18 Medium- and Heavy-Duty Control Measures – Stringency and Timeline for Implementation

Measures	Implementation Begins	12 µg/m ³ Annual PM _{2.5} 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
<p>CARB’s mandatory emission standards for heavy-duty vehicles and engines harmonize with federal standards for NOx and PM emission requirements through 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.</p>		
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
<p>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.</p>		
Zero-Emission Truck Standards – Sales and Manufacturer Requirements		
Advanced Clean Trucks	2024	MSM
<p>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.</p>		
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
<p>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.</p>		
Heavy-Duty On-Board Diagnostics (HD OBD) and OBD II	ongoing	MSM
Amendments to Useful Life & Warranty Provisions (as part of Omnibus)	2024	MSM
<p>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 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</p>		

Measures	Implementation Begins	12 µg/m ³ Annual PM _{2.5} Standard (2012)
<p>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.</p>		
<p>In-Use Emission Control Measures</p>		
<p>Inspection and Maintenance Provisions</p>		
<p>HD Diesel Vehicle Inspection Program (HDVIP)</p>	<p>ongoing</p>	<p>MSM</p>
<p>Periodic Smoke Inspection Program (PSIP)</p>	<p>ongoing</p>	<p>MSM</p>
<p>HD Inspection and Maintenance Program (HD I/M)</p>	<p>ongoing</p>	<p>MSM</p>
<p>Heavy-Duty In-Use Testing Program (HDIUT) (Part of Omnibus Regulation)</p>	<p>2024</p>	<p>MSM</p>
<p>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).</p>		
<ul style="list-style-type: none"> 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. 		
<p>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.</p>		
<p>Diesel Idling Requirements</p>		
<p>HD Idling Reduction Program</p>	<p>ongoing</p>	<p>MSM</p>
<p>Reduced Idling Limits (as part of Omnibus)</p>	<p>2024</p>	<p>MSM</p>
<p>School Bus Idling ATCM</p>	<p>ongoing</p>	<p>MSM</p>
<p>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.</p>		
<p>Fleet Rules - General</p>		
<p>Truck and Bus</p>	<p>ongoing</p>	<p>MSM</p>

Measures	Implementation Begins	12 µg/m ³ Annual PM _{2.5} 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
<p>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:</p>		
<ul style="list-style-type: none"> • 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. 		
<p>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.</p>		
<p>Fleet Rules - Drayage Trucks</p>		
Truck and Bus	ongoing	MSM
Advanced Clean Fleets (ACF) Regulation (2022 State SIP Strategy measure, adopted April 2023)	2024	MSM
<p>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.</p>		
<p>Fleet Rules - Solid Waste Collection Vehicles (SWCVs)</p>		
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
<p>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.</p>		
<p>Fleet Rules - Public Agencies and Utilities</p>		

Measures	Implementation Begins	12 µg/m ³ Annual PM _{2.5} Standard (2012)
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
<p>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.</p>		
Fleet Rules - Transit Agencies		
Fleet Rule for Transit Agencies	ongoing	MSM
Innovative Clean Transit	2023	MSM
<p>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.</p>		
Fleet Rules - Airport Shuttle Buses		
Truck and Bus	ongoing	MSM
Zero-Emission Airport Shuttle Buses	2027	MSM
<p>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.</p>		
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
<p>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.</p>		
Fuels Control Measures		
Conventional Diesel Fuel Standards		
CARB Ultra Low Sulfur Diesel (ULSD)	ongoing	MSM

Measures	Implementation Begins	12 µg/m ³ Annual PM _{2.5} Standard (2012)
<p>Low-Emission Diesel Requirement (2016 State SIP Strategy measure, not yet adopted)</p> <p>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.</p>	TBD	MSM
Alternative Fuel Standards		
Low Carbon Fuel Standard (LCFS)	ongoing	MSM
<p>Alternative Diesel Fuel (ADF) Regulation</p> <p>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.</p>	ongoing	MSM

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 Valley's proposed 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 1,⁹² 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

⁹² Beall, Chapter 5, Statutes of 2017

https://leginfo.legislature.ca.gov/faces/billNavClient.xhtml?bill_id=201720180SB1

nature on a facility basis.

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.

3.4.3 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 Port of Stockton.

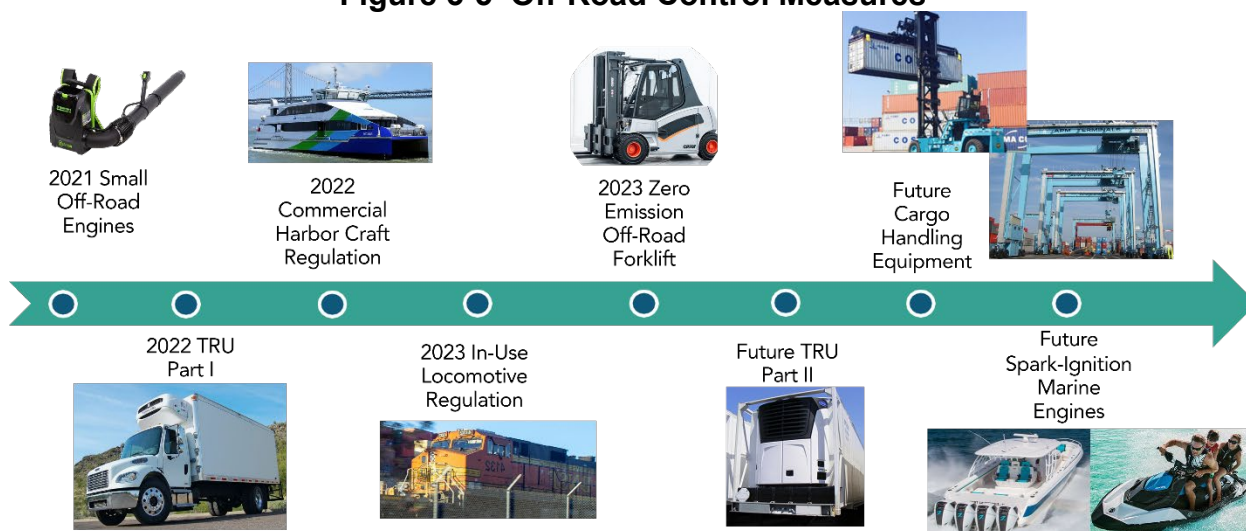
As the Valley is home to one of the most productive agricultural regions in the world, farm equipment is also an important off-road source category for the Valley. The farm equipment category is composed of agricultural equipment that includes tractors, agricultural tractor-trailers, harvesting equipment, sprayers, and other agricultural equipment and engines. 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.

STEP 2(A): CALIFORNIA'S OFF-ROAD CONTROL MEASURES

Emission reductions from ongoing implementation of the current control program are projected to reduce emissions of NO_x and direct PM from the off-road sector by over 54 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 3-5 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 3-19 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 3-19 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 NO_x, 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 NO_x. Lower NO_x 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 NO_x 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 NO_x emissions inventories in California.⁹³
- 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.⁹⁴ Hence, it would be helpful to revise and improve the reporting and recordkeeping requirements.

⁹³ "Evaluation of the feasibility, cost-effectiveness, and necessity of equipping small off-road diesel engines with advanced PM and/or NO_x aftertreatment" – CARB Contract No. 14-300, March 2019, <https://ww2.arb.ca.gov/sites/default/files/2020-10/14-300.pdf>

⁹⁴ "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

- 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,⁹⁵ and that the frequency of in-use low-load- operation⁹⁶ 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 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.

⁹⁵ <https://www.constructionequipment.com/home/blog/10727772/thinking-through-fuel-burn-rates>

⁹⁶ 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

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 PM_{2.5} and NO_x 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. The cleanup of agricultural in-use equipment is primarily an issue in the San Joaquin Valley with their large agricultural economy.

The 2007 SIP included the **2007 Cleaner In-Use Agricultural Equipment Measure** (Ag Measure) to achieve 5 to 10 tpd of NO_x reductions in 2017 by modernizing agricultural equipment in the Valley. The Valley agricultural industry immediately began working on implementing this SIP measure by leveraging federal and local incentives to provide farmers assistance to replace their older, higher polluting equipment with the cleanest available technology. Specifically, new incentive funds were secured through the federal Farm Bill to be used alongside funds from existing programs.

To push beyond the 2007 Ag Measure, CARB staff included in the San Joaquin Valley Supplement to the 2016 State Strategy for the State Implementation Plan (Valley SIP Strategy)⁹⁷ the **Accelerated Turnover of Agricultural Equipment** measure to achieve 11 tpd NO_x reductions in 2024 through the accelerated turnover of approximately 12,000 tier 0, tier 1, and tier 2 agricultural equipment to the cleanest equipment available. This measure led to the appropriation of significant funding and development of CARB's Funding Agricultural Replacement Measures for Emissions Reductions (FARMER) Program. In addition, eligible projects under the SIP measure and through the FARMER program include electrifying agricultural equipment such as utility quads and small yard tractors that are used on farms and ranches. To fulfill the State commitment under the Accelerated Turnover of Agricultural Equipment Measure, CARB developed in 2019 and submitted to U.S. EPA a SIP-creditable incentive measure for a subset of the total emissions reductions that has since been made federally-enforceable upon approval by U.S. EPA into the California SIP.

Incentives are cost-effective in replacing old high-polluting tractors on most farms. However, there are many of these high-polluting tractors still in service on small farms in which the cost of the new tractor is not feasible even with incentives. To provide cleaner tractors to small farms, CARB staff along with the District and the agricultural industry are working to implement a new tractor trade up program through funding provided by a CARB grant. The trade-up program is designed to assist small farmers overcome potential financial barriers to accessing cleaner mobile agricultural technologies, and is intended to accelerate emission reductions by replacing the oldest tractors with cleaner used models. This is accomplished through a multi-step transaction in which an owner of an older, high-emitting piece of mobile agricultural equipment agrees to scrap that

⁹⁷ San Joaquin Valley Supplement to the 2016 State Strategy for the State Implementation Plan
<https://ww2.arb.ca.gov/sites/default/files/classic/planning/sip/2016sip/valleystrategy.pdf>

equipment in exchange for a previously used and reconditioned piece of equipment with a cleaner diesel engine at little or no out-of-pocket cost. The owner of the used equipment is provided incentive funding to assist in the purchase of new equipment that employs the cleanest, commercially available technology.

CARB also included in the Valley SIP Strategy the **Cleaner In-Use Agricultural Equipment** measure to serve as a backstop to accelerate the turnover of large tier 0, tier 1, and tier 2 agriculture tractors to tier 4 through existing projects and new projects. While identifying and securing incentive funding will be an important element going forward, the Cleaner In-Use Agricultural Equipment measure is designed to act as a catalyst for attracting early replacement of agricultural equipment using incentives. The backstop rule could require that by 2030 all agricultural equipment operating in the Valley be Tier 2 or cleaner. In combination, the backstop rule, incentives and significant lead time, ensures cleaner agricultural equipment will be used in the Valley through 2030.

[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+NO_x, 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 NO_x 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+NO_x emission standards for new stern-drive 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 NO_x emissions by approximately 70 percent below the current HC+NO_x 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 2014.⁹⁸

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/m²/day) of total organic gas (TOG) for a 3-day diurnal period, and a fuel hose permeation limit of 15 g/m²/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/m²/day. Authorization was granted by U.S. EPA in 2017.⁹⁹

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.

⁹⁸ 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

⁹⁹ 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

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 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 sunseting 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 2013.¹⁰⁰

In 2010, CARB set **Standards for Zero-Emission SORE Equipment**.¹⁰¹ 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 2015.¹⁰² In 2016, CARB amended its **evaporative emission standards** for the entire category of SORE to increase stringency.¹⁰³

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

¹⁰⁰ 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

¹⁰¹ 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

¹⁰² U.S. EPA 2015. “California State Non-road Engine Pollution Control Standards; Small Off-Road Engines Regulations; Notice of Decision

¹⁰³ CARB 2016. “Final Regulations Order” accessed June 2018
https://www.arb.ca.gov/regact/2016/sore2016/finalreq.pdf?_ga=2.102358145.1039751104.1528225837-29497060.1519676686

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 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***, 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 2009.¹⁰⁴ 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.^{105, 106}

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

¹⁰⁴ 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

¹⁰⁵ 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

¹⁰⁶ 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

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.
- **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.¹⁰⁷ Locomotives are self-propelled vehicles used to push or pull trains, including both freight and passenger operations. Union Pacific Railroad (UP) and BNSF Railway (BNSF) 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

¹⁰⁷ 42 United States Code (U.S.C.) §7547, (a)(5)

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), NO_x, and GHGs. These emissions often occur in or near densely populated areas and neighborhoods, exposing residents to unhealthy levels of toxic diesel PM, plus regional ozone and secondary PM_{2.5}.

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 NO_x reductions through Tier 0, 1, and 2 emission standards. Tier 2 NO_x emission standards reduced older uncontrolled locomotive NO_x 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 particulate matter (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 NO_x and PM emission standards** (2015 and later model years). U.S. EPA Tier 4 NO_x 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 2017¹⁰⁸ 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,¹⁰⁹ CARB staff believes the most technologically feasible advanced technology for near-term deployment is the installation of a compact

¹⁰⁸ <https://ww2.arb.ca.gov/resources/documents/us-epa-responds-carbs-petition-strengthen-locomotive-emission-standards>

¹⁰⁹ Final Technology Assessment for Freight Locomotives available at: <https://www.arb.ca.gov/msprog/tech/report.htm>

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 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 Valley, 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 2010.¹¹⁰ 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

¹¹⁰ 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>

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.
- 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.

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.

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 2020.¹¹¹ 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

¹¹¹ CARB 2022 State SIP Strategy https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf

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:¹¹²

- 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.¹¹³ 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 systems, and many other technologies.¹¹⁴ 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

¹¹² Committee on Aviation Environmental Protection (CAEP) (icao.int) <https://www.icao.int/ENVIRONMENTAL-PROTECTION/Pages/CAEP.aspx>

¹¹³ Clean Air Act sec. 231, 42 U.S.C. § 7571.

¹¹⁴ 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/cleem

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 NO_x 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 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 3-20 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 3-20 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			
<p>New Engine Standards: Off-Road Diesel Engine Emission Standards (general)</p>	<p>Tier 4 Off-Road Engine Standards (CARB and U.S. EPA) Future Measure: <i>Tier 5 Off-Road Vehicles and Equipment measure (CARB)</i></p>	<p>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.</p> <p>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:</p> <ul style="list-style-type: none"> • 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. <p>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. <i>(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)</i></p>	<p>No other state has more stringent exhaust emission standards for off-road equipment than California.</p> <p>Currently CARB and U.S. EPA limit exhaust emissions to same “Tier 4” levels:</p> <ul style="list-style-type: none"> • NOx: 0.3 g/bhp-hr • PM: 0.015 g/bhp-hr
<p>New Engine Standards: Off-Road Zero-Emission Engine Standards (general)</p>	<p>Future Measure: <i>Off-Road Zero-Emission Targeted Manufacturer Rule measure (CARB)</i></p>	<p>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</p>	<p>No other state requires zero-emission off-road engine standards.</p>

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
		sales volume to ensure these globally emerging zero-emissions products and related innovations come to California. <i>(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)</i>	
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: <i>Clean Off-Road Fleet Recognition Program (CARB)</i>	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. <i>(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)</i>	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	Cleaner In-Use Agricultural Equipment (CARB) Accelerated Turnover of Agricultural Equipment Measures (CARB)	California’s in-use emission control program for agricultural equipment is among the most stringent in the nation. CARB’s 2007 <i>State SIP Strategy</i> included the Cleaner In-Use Agricultural Equipment measure, to achieve 5 to 10 tpd of NOx reductions in 2017 by modernizing agricultural equipment in the Valley. To push beyond this, CARB included in the Valley SIP Strategy the Accelerated Turnover of Agricultural Equipment measure to achieve 11 tpd NOx reductions in 2024, by accelerating	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			
	<p>Future Measure: <i>Cleaner In-Use Agricultural Equipment measure (CARB)</i></p>	<p>turnover of approximately 12,000 tier 0, tier 1, and tier 2 agricultural equipment to the cleanest equipment available. To fulfill the State commitment under the Accelerated Turnover of Agricultural Equipment Measure, CARB developed and submitted to U.S. EPA a SIP-creditable incentive measure for a subset of the total projects that has since been made federally-enforceable upon approval by U.S. EPA into the California SIP.</p> <p>CARB is anticipated to further increase the stringency of in-use emission controls a measure designed to accelerate emission reductions from the in-use ag equipment fleet. CARB included the Cleaner In-Use Agricultural Equipment measure in the Valley SIP Strategy to serve as a backstop to accelerate the turnover of large tier 0, tier 1, and tier 2 agriculture tractors to tier 4 through existing projects and new projects. <i>(NOTE: CARB committed to pursue the Cleaner In-Use Agricultural Equipment measure, but this measure has yet to be proposed to the Board for approval/adoption.)</i></p>	
<p>New Engine Standards:</p> <p>Airport Ground Support Equipment (GSE)</p>	<p>Large Spark Ignition (LSI) Fleet Regulation (CARB)</p> <p>Tier 4 Off-Road Engine Standards (CARB and U.S. EPA)</p> <p>Future measure: <i>Zero-Emission Airport Ground Support Equipment measure (CARB)</i></p>	<p>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.</p> <p>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. <i>(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.)</i></p>	<p>No other state has more stringent exhaust emission standards for airport ground support equipment than California.</p>
<p>In-Use Emissions Controls:</p> <p>Fleet Rules (Airport Ground Support Equipment)</p>	<p>In-Use Off Road Diesel-Fueled Fleets Regulation (CARB)</p> <p>Large Spark-Ignition (LSI) Engine Fleet Requirements Regulation (CARB)</p> <p>Portable Diesel-Engines Air Toxic Control Measure (CARB)</p> <p>Future Measure: <i>Zero-Emission Airport Ground Support Equipment measure (CARB)</i></p>	<p>California's in-use emission controls for airport ground support equipment (GSE) are the most stringent in the nation.</p> <p>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.</p> <p>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.</p> <p>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).</p>	<p>No other state or nonattainment area controls airport GSE more stringently than CARB.</p>

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
		<p>CARB is anticipated to further increase the stringency of emission controls with the Zero-Emission Airport Ground Support Equipment measure. <i>(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.)</i></p>	
<p>New Engine Standards:</p> <p>Cargo Handling Equipment (CHE)</p>	<p>Cargo Handling Equipment Regulation (CARB)</p> <p>Future Measure: <i>Cargo Handling Equipment Amendments measure (CARB)</i></p>	<p>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.</p> <p>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. 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. <i>(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)</i></p>	<p>No other state has more stringent exhaust emission standards for cargo handling equipment than California.</p>
<p>In-Use Emissions Controls:</p> <p>Fleet Rules (Cargo Handling Equipment)</p>	<p>Cargo Handling Equipment Regulation (CARB)</p> <p>Future measure: <i>Amendments to the Cargo Handling Equipment measure (CARB)</i></p>	<p>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.</p> <p>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. <i>(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)</i></p>	<p>No other state or nonattainment area has more stringent in-use fleet requirements for CHE than California.</p>
<p>New Engine Standards:</p> <p>Commercial Harbor Craft (CHC)</p>	<p>Commercial Harbor Craft Regulation (CARB)</p>	<p>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.</p> <p>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</p>	<p>No other state has more stringent exhaust emission standards for commercial harbor craft than California.</p>

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
		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.	
In-Use Emissions Controls: Fleet Rules (Commercial Harbor Craft)	Commercial Harbor Craft Regulation (CARB)	<p>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.</p> <p>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.</p>	No other state or nonattainment area controls in-use CHC emissions more stringently than CARB.
New Engine Standards: Forklifts	Tier 4 Off-Road Engine Standards (CARB and U.S. EPA) Future Measures: <i>Zero-Emission Off-Road Forklift Regulation Phase 1 measure (CARB)</i> <i>Off-Road Zero-Emission Targeted Manufacturer Rule measure (CARB)</i>	<p>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.</p> <p>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. <i>(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.)</i></p> <p>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. <i>(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.)</i></p>	No state has more stringent requirements for new emission performance standards for forklifts engines than California.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
<p>In-Use Emissions Controls:</p> <p>Fleet Rules (Forklifts)</p>	<p>Off-road Diesel Regulation (CARB)</p> <p>LSI Fleet Regulation (CARB)</p> <p>2022 Amendments to the In-Use Off-Road Diesel Fueled Fleets Regulation (CARB)</p> <p>Future Measure: <i>Zero-Emission Off-Road Forklift Regulation Phase 1 (CARB)</i></p> <p>Future Measure: <i>Amendments to the Cargo Handling Equipment measure (CARB)</i></p>	<p>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.</p> <p>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.</p> <p>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. <i>(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.)</i></p> <p>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. <i>(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.)</i></p>	<p>No other state or nonattainment area has more stringent fleet requirements for in-use forklifts than CARB.</p>

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
<p>New Engine Standards:</p> <p>Marine Engines</p>	<p>Exhaust Emission Regulations for Spark-Ignition Marine Engines (CARB)</p> <p>Tier II Emission Standards for Inboard and Stern-Drive Marine Engines (CARB)</p> <p>Evaporative Emission Control Standards (CARB)</p> <p>Future Measure: <i>Spark-Ignition Marine Engine Standards measure (CARB)</i></p>	<p>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:</p> <ul style="list-style-type: none"> • 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. <p>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. <i>(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)</i></p>	<p>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.</p>
<p>New Engine Standards:</p> <p>Off-Highway Recreational Vehicles (OHRVs)</p>	<p>Exhaust Emission Standards for OHRVs (CARB)</p> <p>Evaporative Emission Standards for OHRVs (CARB)</p>	<p>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+.</p>	<p>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.</p>
<p>In-Use Emissions Controls:</p> <p>Fleet Rules (Off-Highway Recreational Vehicles)</p>	<p>OHRV "Red Sticker" program (CARB)</p>	<p>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.</p>	<p>No other state or nonattainment area controls in-use emissions from OHRV more stringently than CARB.</p>
<p>New Engine Standards:</p> <p>Small Off-Road Engines (SORE)</p>	<p>Exhaust and Evaporative Standards for Small Off-Road Engines (CARB)</p>	<p>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.</p> <p>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,</p>	<p>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.</p>

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
		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.	
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: <i>Transport Refrigeration Units (TRU) Regulation Part 2 measure (CARB)</i>	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. <i>(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)</i>	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: <i>Transport Refrigeration Units (TRU) Regulation Part 2 measure (CARB)</i>	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. <i>(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)</i>	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)	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	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			
	CARB has petitioned U.S. EPA to further increase stringency. <i>(2016 State SIP Strategy's More Stringent National Locomotive Emission Standards measure)</i>	requirements for remanufactured locomotives (by ~2020) <i>(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.)</i>	
In-Use Emission Controls (Locomotives): In-Use Locomotive Regulation	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 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: <ul style="list-style-type: none"> • 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.
In-Use Emission Controls (Aircraft): Future Measures for Aviation Emission Reductions	Future Measure: <i>Future Measures for Aviation Emission Reductions (CARB)</i>	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.	No state has emission standards for aircraft that differ from U.S. EPA's and FAA's.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
		<p>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.</p> <p><i>(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)</i></p>	
Fuels			
<p>Fuels Standards: Diesel Standards</p>	<p>CARB Diesel Fuel Regulations and Ultra Low Sulfur Diesel (CARB)</p> <p>Future measure: <i>Low Emission Diesel measure (CARB)</i></p>	<p>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.</p> <p>CARB is anticipated to further increase the stringency of controls on criteria pollutant emissions diesel products. <i>(NOTE: CARB has committed to pursue the Low Emission Diesel measure, but it has not yet been proposed to the Board for approval/adoption.)</i></p>	<p>No state requires cleaner burning diesel than California. The California diesel fuel regulations exceed federal requirements in stringency.</p> <p>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.</p>

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
<p>Fuels Standards: Alternative Fuel Standards (Diesel substitutes)</p>	<p>Low Carbon Fuel Standard (LCFS) (CARB) Alternative Diesel Fuel Regulation (ADF) (CARB)</p>	<p>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.</p> <p>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.</p>	<p>No other state has set criteria emission requirements on alternative fuels and alternative fuel blends.</p> <p>The Federal Renewable Fuel Standard (RFS II) does not specify criteria requirements for alternative fuels.</p> <p>Other states with low carbon fuel and/or clean fuel programs:</p> <ul style="list-style-type: none"> • 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 NO_x 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 NO_x 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 NO_x 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 2007 **Cleaner In-Use Agricultural Equipment Measure** modernizes agricultural equipment in the Valley. Since approval of the measure and development of SJVAPCD and CARB incentive programs, the District has replaced over 5,000 tier 0 and tier 1 tractors since 2009 to meet the targeted NOx emission reductions of 5 to 10 tpd by 2017. This program was further reinforced and strengthened with CARB's **Accelerated Turnover of Agricultural Equipment** measure in the Valley SIP Strategy¹¹⁵ to achieve 11 tpd NOx reductions in 2024 through accelerated turnover of approximately 12,000 tier 0, tier 1, and tier 2 agricultural equipment to the cleanest equipment available. To fulfill the State commitment under the Accelerated Turnover of Agricultural Equipment Measure, CARB developed and submitted to U.S. EPA a SIP-creditable incentive measure for a subset of the total projects that has since been made federally-enforceable upon approval by U.S. EPA into the California SIP. CARB also included the **Cleaner In-Use Agricultural Equipment measure** in the Valley SIP Strategy to serve as a backstop to accelerate the turnover of large tier 0, tier 1, and tier 2 agriculture tractors to tier 4 through existing projects and new projects. This measure could be designed to accelerate emission reductions from the in-use ag equipment fleet by incorporating a phase-in approach to support the use of tier 2 or cleaner engines in agricultural tractors in the Valley by 2030. CARB's agricultural equipment fleet controls are among the most stringent in the nation.

[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

¹¹⁵ San Joaquin Valley Supplement to the 2016 State Strategy for the State Implementation Plan
<https://ww2.arb.ca.gov/sites/default/files/classic/planning/sip/2016sip/valleystrategy.pdf>

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 Valley, 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.

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 PM_{2.5}) 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.¹¹⁶

¹¹⁶ 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>

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.

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 3-20 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 3-21 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 3-21 Off-Road Control Measures – Stringency and Timeline for Implementation

Measures	Implementation Begins	12 µg/m ³ 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
<p>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.</p>		
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
<p>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.</p>		
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
<p>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.</p>		
Off-Road Control Measures - Source Category Specific		
Agricultural Equipment		

Measures	Implementation Begins	12 µg/m ³ Annual (2012)
Tier 4 Off-Road Engine Emission Standards 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.	ongoing	MSM
Accelerated Turnover of Agricultural Equipment Measures	ongoing	MSM
Cleaner In-Use Agricultural Equipment Measure (2016 Valley SIP Strategy measure, not yet adopted)	2030	MSM
California's in-use emission control program for agricultural equipment is among the most stringent in the nation. The 2007 Cleaner In-Use Agricultural Equipment Measure modernizes agricultural equipment in the Valley. This program was further reinforced and strengthened with CARB's Accelerated Turnover of Agricultural Equipment measure in the San Joaquin Valley Supplement to the 2016 State Strategy for the State Implementation Plan (Valley SIP Strategy). Since approval of the measures and development of SJVAPCD and CARB incentive programs, the District has replaced over 5,000 tier 0 and tier 1 tractors since 2009 to meet the targeted NOx emission reductions of 5 to 10 tpd by 2017. To fulfill the State commitment under the Accelerated Turnover of Agricultural Equipment Measure, CARB developed and submitted to U.S. EPA a SIP creditable incentive measure for a subset of the total projects that has since been made federally-enforceable upon approval by U.S. EPA into the California SIP. CARB is anticipated to further increase the stringency of in use emission controls with the Cleaner In-Use Ag Equipment measure, committed to in the Valley SIP Strategy, which would be designed to accelerate emission reductions from the in use ag equipment fleet by incorporating a phase-in approach to support the use of tier 2 or cleaner engines in agricultural tractors in the Valley by 2030 which was committed to in the Valley SIP Strategy. California's agricultural equipment fleet rules are among the most stringent in the nation. 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. California's currently committed to in-use agricultural equipment control measures are the most stringent in the nation, further increases in stringency are not feasible.		
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:		
<ul style="list-style-type: none"> • 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 µg/m ³ Annual (2012)
Amendments to CHE Regulation (2022 State SIP Strategy measure with commitment)	2026	MSM
<p>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.</p>		
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
<p>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.</p>		
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
<p>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:</p> <ul style="list-style-type: none"> • 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. 		

Measures	Implementation Begins	12 µg/m ³ Annual (2012)
<p>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 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</p>		
<p>Marine Engines</p>		
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
<p>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:</p> <ul style="list-style-type: none"> • 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. <p>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.</p> <p>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.</p>		
<p>Off-Highway Recreational Vehicles (OHRV)</p>		
Exhaust and Evaporative Emission Standards for OHRVs	ongoing	MSM
<p>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.</p>		
<p>Small Off-Road Engines</p>		
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
<p>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.</p>		
<p>Transport Refrigeration Units (TRUs)</p>		

Measures	Implementation Begins	12 µg/m ³ Annual (2012)
ATCM for In-Use Diesel-Fueled Transport Refrigeration Units (TRUs) and TRU Generator Sets	ongoing	MSM
Transport Refrigeration Unit Regulation Part 2 (2022 State SIP Strategy measure with commitment)	2028	MSM
<p>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.</p>		

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 Aviation Control Measures

Future Measures for Aviation Emission Reductions (2022 State SIP Strategy measure with commitment)	2029	MSM
<p>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.</p>		

Measures	Implementation Begins	12 µg/m ³ Annual (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
<p>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.</p>		
Alternative Fuel Standards		
Low Carbon Fuel Standard (LCFS)	ongoing	MSM
Alternative Diesel Fuel (ADF)	ongoing	MSM
<p>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.</p>		

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 Valley's proposed 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.

3.4.4 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 San Joaquin Valley controls emissions from commercial and residential building appliances through two rules, Rule 4902: Residential Water Heaters, and Rule 4905: Natural Gas-Fired, Fan-Type Central Furnaces. Both of these rules limit the types of residential water heaters and furnaces that may be sold in the Valley. Rule 4902 applies to natural gas-fired, residential water heaters with heat input rates less than or equal to 75,000 Btu/hr. The District amended the rule in 2009 to tighten NO_x emission limits. Rule 4905 applies to natural gas-fired, fan-type central furnaces with heat input rates less than 175,000 Btu/hr, and combination heating and cooling units with a rated cooling capacity of less than 65,000 Btu/hr. The District amended Rule 4905 in 2015 to tighten the NO_x emission limits for residential units, and to expand the types of appliances covered by the rule to include commercial units and manufactured homes.

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 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.

STEP 2(B): OTHER STATES’ AND NONATTAINMENT AREAS’ COMMERCIAL AND RESIDENTIAL BUILDING APPLIANCES CONTROL MEASURES

Table 3-22 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 3-22 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			
<i>Space and Water Heaters</i>			
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. <i>(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)</i>	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. ¹¹⁷ 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. ¹¹⁸

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

¹¹⁷ 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>.

¹¹⁸ New York State Energy Research and Development Authority. 2022. “New York’s Carbon Neutral Buildings Roadmap.” Available at: <https://www.nysrerda.ny.gov/All-Programs/Carbon-Neutral-Buildings>.

Table 3-22 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 3-22 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.¹¹⁹ 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

¹¹⁹ 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.¹²⁰ 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”.

¹²⁰ 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%20Equitable%20Decarb%20March%202022.pdf>

Table 3-23 Commercial and Residential Building Appliances Control Measures – Stringency and Timeline for Implementation

Measures	Implementation Begins	12 µg/m ³ Annual (2012)
State SIP Strategy Residential and Commercial Building Appliance Measures (with Commitment)		
Zero Emission Standard for Space and Water Heaters measure	2030	MSM
<p>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</p>		

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 Valley's proposed 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.

3.4.5 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 Valley (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 and proposed in the Valley 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 Valley PM_{2.5} SIPs in Step 2(c), and found no mobile source control measures that were proposed in previous Moderate or Serious attainment plan control strategies for the Valley that were not subsequently adopted.

As there are no applicable control measures previously rejected as infeasible for the Valley'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 Valley's 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 Valley's SIP would be commercially

available and/or technologically and economically feasible to implement in the Valley in the timeframe required for the area's PM_{2.5} SIPs. The control measures analyzed in this document therefore meet the requirements of Most Stringent Measures (MSM).

3.5 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 Valley's 12 $\mu\text{g}/\text{m}^3$ annual PM_{2.5} SIP 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 Valley.

Board adoption of the proposed Valley SIP for the 12 $\mu\text{g}/\text{m}^3$ annual PM_{2.5} standard – including the control measures described in the 2022 State SIP Strategy – will satisfy the requirements of Step 4.

3.6 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 BACM and MSM requirements as part of their 2004 approval of the Valley's 2003 PM10 Plan:

"We believe that the State's control programs constitute BACM at this time for the mobile source and fuels categories, since the State's measures reflect the most stringent emission control programs currently available, taking into account economic and technological feasibility."

Additionally, in their 2020 proposed approval of the San Joaquin Valley's PM2.5 Serious Area 2018 Plan,¹²¹ 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."¹²²

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

¹²¹ 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.

¹²² 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 both PM2.5 standard in this analysis.

This page intentionally blank.