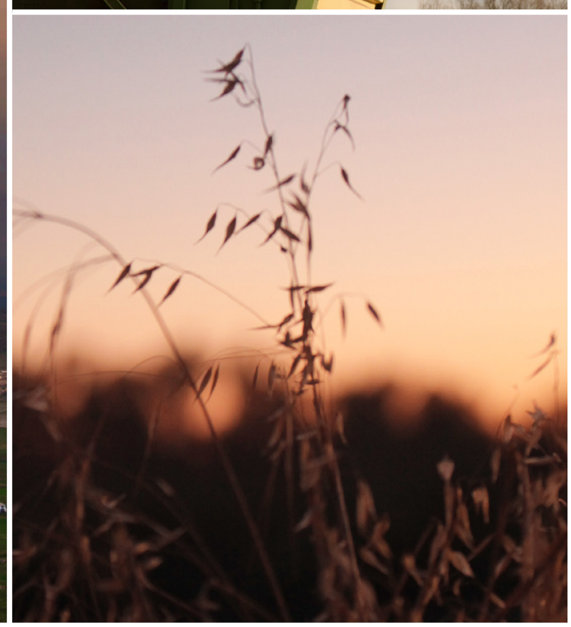
Initial SIP Requirements for the 2012 Annual PM2.5 Standard

Adopted October 19, 2023



San Joaquin Valley
AIR POLLUTION CONTROL DISTRICT®

TABLE OF CONTENTS

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Chapter 1
OVERVIEW

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TABLE OF CONTENTS

Chapter 1: Overview

1.1 INTRODUCTION

Over the years, the San Joaquin Valley Air Pollution Control District (District) and the California Air Resources Board (CARB) have adopted numerous attainment plans (State Implementation Plans, or SIPs), which serve as the primary vehicles for improving air quality in the San Joaquin Valley (Valley). These SIPs use extensive science and research, state of the art air quality modeling, and the best available information to develop a strategy to bring the Valley into attainment with federal health-based air quality standards. Each SIP builds upon the work of prior plans, while establishing the path for continued air quality improvements. Following the adoption of each attainment plan, the District implements plan strategies through regulatory development, outreach, continued research, and incentive programs. Each attainment plan is just one milestone in the District's continued effort to improve air quality in the Valley.

Under previous District attainment plans, the District has implemented generations of emissions control measures for stationary and area sources under its jurisdiction. Similarly, CARB has adopted stringent regulations for mobile sources. Together, these efforts represent the nation's toughest air pollution emissions controls. In addition to the stringent regulatory program, the District also operates amongst the most effective and efficient incentive grants program, investing over $5.7 billion in public/private funding towards clean air projects to date that have achieved over 250,000 tons of emissions reductions. Due to significant investments from the District to implement strategies from past attainment plans, the Valley's ozone and fine particulate matter (PM2.5) precursor emissions are at historically low levels, and air quality has improved significantly, providing Valley residents with associated health benefits. The Valley has already attained the 1987 PM10 standard and the 1979 1-hour ozone standard. Additionally, on January 28, 2022, EPA determined that the Valley attained the 1997 24-hour PM2.5 standard of 65 micrograms per cubic meter ($\mu g/m^3$) by the attainment date of December 31, 2020.[1]

Despite the progress made to improve the Valley's air quality through implementation of multiple attainment plans adopted by the District and clean air investments by Valley businesses and residents, substantial additional emissions reductions are needed, particularly from mobile sources under CARB and U.S. Environmental Protection Agency (EPA) jurisdiction that make up over 80% of remaining Valley NOx emissions.

[1] EPA. *Partial Approval and Partial Disapproval of Air Quality Implementation Plans and Determination of Attainment by the Attainment Date; California; San Joaquin Valley Serious Area and Section 189(d) Plan for Attainment of the 1997 24-hour PM2.5 NAAQS; Final Rule*. 87 Fed. Reg. 19, pp. 4503-4508. (January 28, 2022). Retrieved from: https://www.federalregister.gov/documents/2022/01/28/2022-01728/partial-approval-and-partial-disapproval-of-air-quality-implementation-plans-and-determination-of

1.2 NATIONAL AMBIENT AIR QUALITY STANDARDS FOR PARTICULATE MATTER

The federal Clean Air Act (CAA) Section (§§) 108 and 109 require EPA to establish health-based ambient air quality standards (national ambient air quality standards, or NAAQS) for six criteria pollutants, including PM2.5. EPA designates an area as attainment or nonattainment based on the most recent three years of air quality data available. Under the CAA Subpart 4,[2] PM2.5 nonattainment areas are initially classified as "Moderate," with six years from the initial nonattainment designation date to reach attainment (though two one-year extensions are available in certain circumstances). Areas may request reclassification to "Serious," with ten years from the initial attainment designation date to reach attainment. In addition to the attainment deadline, a nonattainment area's classification sets specific planning requirements under the CAA. The guidelines for demonstrating compliance with these requirements are provided in EPA's 2016 Implementation Rule.[3]

1.2.1 2012 Annual PM2.5 Standard

On January 15, 2013, EPA revised the annual average PM2.5 standard to 12 μg/m³ (2012 PM2.5 standard), while retaining the 24-hour standard of 35 μg/m³ as established in 2006.[4] In 2015, EPA designated the Valley as Moderate nonattainment for the 2012 PM2.5 standard, with an attainment deadline of December 31, 2021.[5] Due to the impracticability of achieving the standard by the Moderate area attainment date, the District adopted the *2016 Moderate Area Plan for the 2012 PM2.5 Standard* (*2016 Moderate Plan*), including an attainment impracticability demonstration and a request for reclassification of the Valley from Moderate nonattainment to Serious nonattainment. Effective on December 27, 2021, EPA finalized partial approval of the District's *2016 Moderate Plan*, as updated by the District's *2018 Plan for the 1997, 2006, and 2012 PM2.5 Standards* (*2018 PM2.5 Plan*), and reclassified the District as a Serious nonattainment area for the 2012 PM2.5 NAAQS, with an attainment deadline of December 31, 2025.[6]

Prior to EPA approving the *2016 Moderate Plan*, the District addressed the Serious Plan requirements for the 2012 annual standard, along with other PM2.5 standards, as part of the integrated *2018 Plan for the 1997, 2006, and 2012 PM2.5 Standards* (*2018*

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[2] Federal Clean Air Act §§188, 189, and 190

[3] EPA. *Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule*. 81 Fed. Reg. 164, pp. 58010-58162. (2016, August 24). (to be codified at 40 CFR Parts 50, 51, and 93). https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf

[4] EPA. *National Ambient Air Quality Standards for Particulate Matter; Final Rule.* 78 Fed. Reg. 10, pp. 3086-3287 (January 15, 2013). (to be codified at 40 CFR Parts 50, 51, 52 et al.). Retrieved from: http://www.gpo.gov/fdsys/pkg/FR-2013-01-15/pdf/2012-30946.pdf

[5] EPA. *Air Quality Designations for the 2012 Primary Annual Fine Particle (PM2.5) NAAQS; Final Rule*. 80 Fed. Reg. 10, pp. 2206-2284. (January 15, 2015). Retrieved from: http://www.gpo.gov/fdsys/pkg/FR-2015-01-15/pdf/2015-00021.pdf

[6] EPA. *Clean Air Plans; California; San Joaquin Valley Moderate Area Plan and Reclassification as Serious Nonattainment for the 2012 PM2.5 NAAQS; Contingency Measures for the 2006 PM2.5 NAAQS; Final Rule.* 86 Fed. Reg. 225, pp. 67343-67350. (November 26, 2021). Retrieved from: https://www.govinfo.gov/content/pkg/FR-2021-11-26/pdf/2021-25616.pdf

PM2.5 Plan), years earlier than required in order to achieve early emissions reductions. In December 2021, EPA proposed approval of the Serious Plan for the 2012 PM2.5 standard,[7] then reversed the decision and proposed disapproval in October 2022.[8] In response to EPA's reversal, CARB withdrew the Plan for the 2012 standard with District concurrence.

As a result of EPA's reclassification of the San Joaquin Valley as a Serious nonattainment area for the 2012 PM2.5 NAAQS, in addition to CARB withdrawing the portions of the *2018 PM2.5 Plan* for the 2012 PM2.5 NAAQS, California is required to submit, within 18 months after the effective date of the reclassification, an emissions inventory, provisions to assure that best available control measures (BACM) shall be implemented no later than four years after the date of reclassification, and any Nonattainment New Source Review (NNSR) SIP revisions required to satisfy the requirements of CAA §§ 189(b)(3) and 189(e).

Pursuant to the Serious area plan requirements, this document contains the District and CARB's precursor demonstration, the demonstration that BACM for the control of direct PM2.5 and PM2.5 precursors are implemented no later than four years after reclassification of the area, and a comprehensive, accurate, and current inventory of actual emissions from all sources of PM2.5 and PM2.5 precursors. Additionally, the District recently adopted revisions to District Rule 2201 (New and Modified Stationary Source Review Rule) in April 2023, which fulfills the requirements for Serious PM2.5 nonattainment areas.

California is also required to submit, within 24 months after the effective date of reclassification, a Serious area plan that satisfies the requirements of part D of title I of the CAA, including a demonstration that the Valley will attain the 2012 PM2.5 standard as expeditiously as practicable in accordance with the requirements of CAA §§ 189(b) and 188(e). Additional Serious area plan requirements include provisions for reasonable further progress (RFP), quantitative milestones, provisions to assure that control requirements applicable to major stationary sources of PM2.5 also apply to major stationary sources of PM2.5 precursors, and contingency measures to be implemented if the area fails to meet RFP or to attain by the applicable attainment date.

1.3 PUBLIC PROCESS

To ensure that the public has had the opportunity for meaningful participation in the development of the upcoming planning efforts, the District provided multiple opportunities for the public to learn more about air quality and to provide the District with comments to help guide Plan development. The District hosted an initial workshop to begin the public process for Plan development on March 23, 2023. At this meeting, the

[7] EPA. *Clean Air Plans; 2012 Fine Particulate Matter Serious Nonattainment Area Requirements; San Joaquin Valley, California; Proposed Rule*. 86 Fed. Reg. 247, pp. 74310-74352. (December 29, 2021). Retrieved from: https://www.govinfo.gov/content/pkg/FR-2021-12-29/pdf/2021-27796.pdf
[8] EPA. *Clean Air Plans; 2012 Fine Particulate Matter Serious Nonattainment Area Requirements; San Joaquin Valley, California; Proposed Rule*. 87 Fed. Reg. 192, pp. 60494-60531. (October 5, 2022). Retrieved from: https://www.govinfo.gov/content/pkg/FR-2022-10-05/pdf/2022-21492.pdf

District invited the public to provide input at multiple checkpoints throughout the presentation to encourage discussion, interaction, and engagement, specifically seeking suggestions on a meaningful public engagement process for plan development, as well as topics to be covered in future workshops. The District held subsequent public workshops on May 11, 2023, and September 7, 2023, to present and discuss plan development and to provide details on the control measure analyses, emissions inventory, and precursor modeling analysis.

At all workshops, the District and CARB provided both English and Spanish workshop materials, and provided simultaneous Spanish interpretation. Additionally, the District provided regular updates at public meetings, including the District Governing Board, Citizens Advisory Committee (CAC), and Environmental Justice Advisory Group (EJAG). The District published drafts of Chapter 4 (Precursor Demonstration) and Chapter 5 (Emissions Inventory) on August 28, 2023, for public review ahead of the September workshop. The *Proposed Initial SIP Requirements for the 2012 Annual PM2.5 Standard* was published on September 19, 2023, ahead of the October 19, 2023, public hearing. Public comments have been incorporated into the analyses as appropriate. The District and CARB will continue the public process for the remainder of the Plan requirements through 2023.

Chapter 2

STATIONARY & AREA SOURCE BEST AVAILABLE CONTROL MEASURE ANALYSIS

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TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

Chapter 2: Stationary and Area Source Best Available Control Measure (BACM) Analysis

OVERVIEW

The San Joaquin Valley (Valley) faces significant challenges in meeting federal air quality standards (also called National Ambient Air Quality Standards, or NAAQS) for fine particulate matter (PM2.5) and ozone. The San Joaquin Valley Air Pollution Control District (District) has demonstrated leadership in developing and implementing groundbreaking regulatory strategies to reduce emissions. Tough and innovative rules, such as those for indirect source review, residential wood burning, glass manufacturing, and agricultural burning, have set benchmarks for California and the nation.

Over the years, the District's numerous air quality plans (State Implementation Plans, or SIPs) have been a primary vehicle for improving air quality in the Valley. Each plan builds upon the work of prior plans while establishing the path for continued air quality improvements. Consistent with this planning continuity, the District's control measure evaluation in this section is built upon analyses under the District's prior attainment plans, including but not limited to the *2007 Ozone Plan,*[1] *2008 PM2.5 Plan,*[2] *2012 PM2.5 Plan,*[3] *2013 Plan for the Revoked 1-Hour Ozone Standard,*[4] *2015 Plan for the 1997 PM2.5 Standard,*[5] *2016 Plan for the 2008 8-Hour Ozone Standard* (*2016 Ozone Plan*),[6] *2016 Moderate Area Plan for the 2012 PM2.5 Standard* (*2016 PM2.5 Plan*),[7] *2018 Plan for the 1997, 2006, and 2012 PM2.5 Standards* (*2018 PM2.5 Plan*),[8] and the *2022 Plan for the 2015 8-Hour Ozone Standard* (*2022 Ozone Plan*).[9]

This section reflects the comprehensive evaluation performed by the District to examine emissions sources in the Valley to ensure that the best available control measures (BACM) for directly emitted PM2.5 and all significant PM2.5 precursors are implemented as required for Serious PM2.5 nonattainment areas under Part D, Subpart 4 of the Clean Air Act (CAA). Although all District rules meet BACM for purposes of this

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[1] SJVAPCD. *2007 Ozone Plan*. (April 30, 2007). Retrieved from: http://www.valleyair.org/air_quality_plans/docs/AQ_Ozone_2007_Adopted/2007_8HourOzone_CompletePlan.pdf
[2] SJVAPCD. *2008 PM2.5 Plan*. (April 30, 2008). Retrieved from: http://www.valleyair.org/Air_Quality_Plans/AQ_Final_Adopted_PM25_2008.htm
[3] SJVAPCD. *2012 PM2.5 Plan*. (December 20, 2012). Retrieved from: http://www.valleyair.org/Air_Quality_Plans/PM25Plan2012/CompletedPlanbookmarked.pdf
[4] SJVAPCD. *2013 Plan for the Revoked 1-Hour Ozone Standard*. (September 19, 2013). Retrieved from: https://www.valleyair.org/Air_Quality_Plans/OzoneOneHourPlan2013/AdoptedPlan.pdf
[5] SJVAPCD. *2015 Plan for the 1997 PM2.5 Standard*. (April 16, 2015). Retrieved from: http://www.valleyair.org/Air_Quality_Plans/PM25Plans2015.htm
[6] SJVAPCD. *2016 Ozone Plan for 2008 8-Hour Ozone Standard*. (June 16, 2016). Retrieved from: http://valleyair.org/Air_Quality_Plans/Ozone-Plan-2016/Adopted-Plan.pdf
[7] SJVAPCD. *2016 Moderate Area Plan for the 2012 PM2.5 Standard*. (September 15, 2016). Retrieved from: http://www.valleyair.org/Air_Quality_Plans/docs/PM25-2016/2016-Plan.pdf
[8] SJVAPCD. *2018 Plan for the 1997, 2006, and 2012 PM2.5 Standards*. (November 15, 2018). Retrieved from: https://www.valleyair.org/pmplans/documents/2018/pm-plan-adopted/2018-Plan-for-the-1997-2006-and-2012-PM2.5-Standards.pdf
[9] SJVAPCD. *2022 Plan for the 2015 8-Hour Ozone Standard*. (December 15, 2022). Retrieved from: https://ww2.valleyair.org/media/q55posm0/0000-2022-plan-for-the-2015-8-hour-ozone-standard.pdf

evaluation, the District will continue to review opportunities to go beyond BACM as part of ongoing Plan development.

This section consists of a literature review and evaluation of emission reduction opportunities for stationary and area source categories. District staff in multiple departments with expertise in these various sectors contributed to this effort. The evaluations in this section are intended to capture relevant background information, examine emission reduction opportunities for technological and economic feasibility, make recommendations for appropriate District actions moving forward, solicit public input during the Plan development process, and demonstrate compliance with CAA control strategy requirements for PM2.5 nonattainment areas.

Clean Air Act Requirements

With respect to Plan requirements, CAA §189(b)(1)(B) states that an area designated as Serious nonattainment must submit provisions to assure BACM, including best available control technology (BACT) for control of PM2.5, are implemented no later than four years after the date an area is reclassified to Serious. The guidelines for demonstrating compliance with these requirements are provided in the U.S. Environmental Protection Agency's (EPA) 2016 PM2.5 Implementation Rule.[10] Within the rule, EPA defined BACM to be *"the maximum degree of emission reduction achievable from a source or source category which is determined on a case-by-case basis, considering energy, economic and environmental impacts and other costs."*

Pursuant to control strategy requirements contained in 40 CFR 51.1010 (a)(1)-(5), a Serious nonattainment area shall identify, adopt, and implement best available control measures, including control technologies, on sources of direct PM2.5 emissions and sources of emissions of PM2.5 plan precursors located in any Serious PM2.5 nonattainment area or portion thereof located within the state.

As EPA reclassified the District to Serious nonattainment for the 2012 PM2.5 standard effective December 27, 2021, the District is required to implement BACM by 2025.

Demonstration of BACM for the 2012 PM2.5 Standard

This document contains the necessary supporting information to demonstrate compliance with requirements for BACM, and additional feasible measures contained within 40 CFR 51.1010 (a)(1)-(5), including the following:

- ✓ A list of all emissions source categories, sources and activities in the nonattainment area that emit direct PM2.5 or any PM2.5 precursor (Chapter 5);
- ✓ For each source category, source or activity in the nonattainment area, an inventory of direct PM2.5 and all PM2.5 precursor emissions (Chapter 5);

[10] EPA. *Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule*. 81 Fed. Reg. 164, pp. 58010-58162. (August 24, 2016). (Codified at 40 CFR Parts 50, 51, and 93). Retrieved from: https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf

- ✓ For each source category, source or activity in the nonattainment area, a comprehensive list of potential control measures considered by the state for the nonattainment area;
- ✓ For each potential control measure considered by the state but eliminated from further consideration due to a determination by the state that the control measure or technology was not technologically feasible, a narrative explanation and quantitative or qualitative supporting documentation to justify the state's conclusion;
- ✓ For each technologically feasible emission control measure or technology, the following information relevant to economic feasibility: (i) The control efficiency by pollutant; (ii) the possible emissions reductions by pollutant; (iii) the estimated cost per ton of pollutant reduced; and, (iv) a determination of whether the measure is economically feasible, with narrative explanation and quantitative supporting documentation to justify the state's conclusion;
- ✓ For each technologically and economically feasible emission control measure or technology, the date by which the technology or measure can be implemented.

Significant Precursors

Pursuant to CAA §189(e), the sole explicit reference to the regulation of precursors in CAA Subpart 4, the control requirements applicable under plans addressing a PM2.5 NAAQS shall apply to major stationary sources of PM2.5 precursors, except where EPA determines that such sources do not contribute significantly to PM2.5 levels which exceed the standard in the area. As provided in Chapter 4 of this document, modeling demonstrates that volatile organic compounds (VOC), ammonia, and sulfur oxides (SOx) are not significant precursors for the formation of PM2.5 in the Valley. Therefore, CARB and the District have excluded controls for VOC, SOx, and ammonia from this evaluation.

Although the District is not required to evaluate sources of ammonia as stated above, the District and CARB conducted a full analysis of the potential control of ammonia sources, including an evaluation of BACM feasible for implementation in the Valley. This analysis is included within the precursor demonstration in Chapter 4.

EVALUATION METHODOLOGY

Each stationary and area source control measure evaluation in this chapter follows a thorough and consistent analysis methodology, modeled after EPA's guidance for BACM requirements as described in the section above. This methodology includes sections for the following discussions and analyses:

- Emissions inventory
- Rule description
- Regulatory evaluation of federal, state, and local regulations, including an assessment of BACM
- Summary of potential emission reduction opportunities identified and the associated analyses of such opportunities
- Summary of the evaluation findings

Although the District follows this methodology for each individual stationary and area source control measure evaluation, additional sections may be added as appropriate to provide a more complete summary of the analyses performed. The following is a more detailed description of the sections in the control measure analyses.

Emissions Inventory

Each control measure evaluation contains an emissions inventory table that identifies PM2.5 and NOx emissions for the respective source category. The emissions data in each table is provided as an annual average, as well as a wintertime average (November through April), which is the period in which PM2.5 concentrations in the Valley are the highest. The data provided in this section is a compilation of the data sources identified in the emissions inventory section. See Chapter 5 (Emissions Inventory) for additional information.

Rule Description

This section provides an overview of the rule, including rule applicability, types of sources subject to rule requirements, rule adoption/amendment history, and any other additional pertinent details, as relevant to the control measure evaluation.

How does the District Rule compare with federal and state rules and regulations?

As part of the regulatory evaluation, District rules and source categories are compared to federal and state air quality regulations and standards. The following regulations and guidelines are referenced in the comparisons:

Federal Regulations
Federal regulations include the following regulations and guidance documents:
- Control Techniques Guidelines (CTG)[11]
- Alternative Control Techniques (ACT)[12]
- New Source Performance Standards (NSPS)[13]

State Regulations
Generally, state regulations are specific to mobile sources and consumer products. However, there are some California Health and Safety Code (CH&SC) requirements and CARB Airborne Toxic Control Measures (ATCM)[14] that apply to stationary and area sources. While most of the rules evaluated in this Plan do not have a state regulation associated with their source category, any relevant state guidelines are evaluated within this section.

How does the District Rule compare to rules in other air districts?

The District compared every control measure to analogous regulations adopted by California's most progressive air districts. Investigation of control strategies and measures in other air districts and agencies includes, but is not limited to, the following air districts:

- Bay Area Air Quality Management District (BAAQMD)[15]
- South Coast Air Quality Management District (SCAQMD)[16]
- Sacramento Metropolitan Air Quality Management District (SMAQMD)[17]
- Ventura County Air Pollution Control District (VCAPCD)[18]

Local and regional agencies tailor their regulations, analysis, and innovation based on their unique situations. Therefore, regional regulations will differ in language and structure due to differences in local needs and priorities. Thus, comparing individual lines of regulatory text from a range of jurisdictions out of context does not establish BACM on its own. Instead, the District carefully reviews differences between rules with focus on what the regulation as a whole accomplishes while acknowledging differences in regional situations.[19] All potential measures were thoroughly evaluated using the key

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[11] EPA. Control Techniques Guidelines. Retrieved from: http://www.epa.gov/groundlevelozone/SIPToolkit/ctgs.html
[12] EPA. Alternative Control Techniques. Retrieved from: http://www.epa.gov/groundlevelozone/SIPToolkit/ctgs.html
[13] EPA. 40 CFR 60 – Standards of Performance for New Stationary Sources (NSPS). Retrieved from: http://www.tceq.state.tx.us/permitting/air/rules/federal/60/60hmpg.html
[14] CARB. Airborne Toxic Control Measures (ATCMs). Retrieved from: http://www.arb.ca.gov/toxics/atcm/atcm.htm
[15] Bay Area Air Quality Management District (BAAQMD). Rules and Regulations. Retrieved from: http://www.baaqmd.gov/Divisions/Planning-and-Research/Rules-and-Regulations.aspx
[16] South Coast Air Quality Management District (SCAQMD). Rules and Regulations. Retrieved from: http://www.aqmd.gov/home/regulations/rules/scaqmd-rule-book/table-of-contents
[17] Sacramento Metropolitan Air Quality Management District (SMAQMD). Rules and Regulations. Retrieved from: http://www.airquality.org/rules/
[18] Ventura County Air Pollution Control District (VCAPCD). Rules and Regulation. Retrieved from: http://www.vcapcd.org/Rulebook/RuleIndex.htm
[19] Similarly, when EPA acts on control measure analysis, EPA considers a rule "as a whole." See, e.g., EPA's Technical Support Document, *EPA Evaluation of BACM/MSM for the San Joaquin Valley PM2.5 Plan for the 2006 PM2.5 NAAQS* at page 5, supporting final BACM/MSM approval available at 85 FR 44192.

factors identified in EPA's 2016 Implementation Rule[20] to determine if potential opportunities qualify as BACM for the Valley.

Potential Emission Reduction Opportunities

The District reviewed the following areas to identify any additional potential BACM, exclusive of potential BACM evaluated in the "Regulatory Evaluation" section:

- Any emission reduction opportunities identified/considered in previously adopted District plans that were determined to be infeasible at that time.
- New emission reduction opportunities adopted in California SIPs, SIPs in other states, or achieved in practice in other areas.

All potential BACM identified were then thoroughly evaluated for technological and economic feasibility:

- **Technological feasibility** – The technological feasibility analysis determines if a potential opportunity to reduce emissions is viable for existing facilities and operators in the Valley, given their current operating needs and restrictions. This analysis includes a literature review of District permits; environmental and technological studies; EPA and CARB guideline documents; and other air districts' rules, regulations, and guidelines, to identify potential opportunities and determine the technological feasibility of any identified potential opportunities.
- **Economic feasibility** – To determine economic feasibility, the District conducts a cost effectiveness analysis to evaluate the economic reasonableness of an air pollution control measure or technology as it applies to entities/residents in the Valley. A cost effectiveness analysis examines the added cost, in dollars per year, of the control technology or technique, divided by the emissions reductions achieved, in tons per year (tpy).

The District reviewed staff reports and studies from other air districts, EPA technical guidance documents, and applicable study data from the scientific community to assist in evaluating the technological and economic feasibility of potential BACM.

Evaluation Findings

This section completes the control measure evaluation and provides a summary of the District's findings based on the control measure evaluation.

[20] EPA. *Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule*. 81 Fed. Reg. 164, pp. 58010-58162. (August 24, 2016). (Codified at 40 CFR Parts 50, 51, and 93). Retrieved from: https://www.gpo.gov/fdsys/pkg/FR-2016-08-24/pdf/2016-18768.pdf

SUMMARY OF CONTROL MEASURES

The District's stringent regulations already adopted under previous attainment plans also serve as control measures for this Plan. These adopted regulations reduce directly emitted PM2.5 and NOx and contribute to the Valley's progress toward attainment of PM2.5 standards as they are fully implemented. Each control measure evaluated within this chapter and the District's resulting conclusion is summarized in Table 2-1 below.

Table 2-1 District Control Measures Evaluated for BACM

District Rule		Date Adopted or Last Amended	Conclusion
4103	Open Burning	6/17/2021	BACM
4104	Reduction of Animal Matter	12/17/1992	BACM
4106	Prescribed Burning and Hazard Reduction Burning	6/21/2001	BACM
4203	Particulate Matter Emissions from Incineration of Combustible Refuse	12/17/1992	BACM
4204	Cotton Gins	2/17/2005	BACM
4301	Fuel Burning Equipment	12/17/1992	BACM
4306/ 4320	Boilers, Steam Generators, and Process Heaters, >5 MMBtu/hr	12/17/2020	BACM
4307	Boilers, Steam Generators, and Process Heaters, 2-5 MMBtu/hr	4/21/2016	BACM
4308	Boilers, Steam Generators, and Process Heaters, 0.075-2 MMBtu/hr	11/14/2013	BACM
4309	Dryers, Dehydrators, and Ovens	12/15/2005	BACM
4311	Flares	12/17/2020	BACM
4313	Lime Kilns	3/27/2003	BACM
4352	Solid Fuel Fired Boilers, Steam Generators, and Process Heaters	12/16/2021	BACM
4354	Glass Melting Furnaces	12/16/2021	BACM
4550	Conservation Management Practices	8/19/2004	BACM
4692	Commercial Charbroiling	6/21/2018	BACM
4702	Internal Combustion Engines	8/19/2021	BACM
4703	Stationary Gas Turbines	9/20/2007	BACM
4901	Wood Burning Fireplaces and Wood Burning Heaters	5/18/2023	BACM
4902	Residential Water Heaters	3/19/2009	BACM
4905	Natural Gas-Fired, Fan-type Central Furnaces	12/16/2021	BACM
8011	General Requirements	8/19/2004	BACM
8021	Construction, Demolition Excavation, Extraction, and Other Earthmoving Activities	8/19/2004	BACM
8031	Bulk Materials	8/19/2004	BACM
8041	Carryout and Trackout	8/19/2004	BACM
8051	Open Areas	8/19/2004	BACM
8061	Paved and Unpaved Roads	8/19/2004	BACM
8071	Unpaved Vehicle/Equipment Traffic Areas	9/16/2004	BACM
8081	Agricultural Sources	9/16/2004	BACM

2.1 RULE 4103 (OPEN BURNING)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	9.20	9.14	9.05	1.79	1.78	1.77	1.77
NOx	6.55	6.51	6.44	1.48	1.47	1.46	1.46
	Winter Average - Tons per day						
PM2.5	12.47	12.38	12.25	2.45	2.43	2.42	2.42
NOx	8.84	8.78	8.69	2.00	1.99	1.98	1.97

District Rule 4103 Description

Historically, agricultural materials such as prunings and orchard removals have been disposed of through burning to prevent the spread of plant diseases and to control weeds and pests in an economical and timely manner. The District first adopted Rule 4103 (Open Burning) on June 18, 1992, to regulate and coordinate the use of open burning while minimizing smoke impacts on the public. The District has since amended and increased the stringency of Rule 4103 seven times. In 2003, California Senate Bill (SB) 705 (Florez, 2003), codified in CH&SC §§41855.5 and 41855.6, established a schedule to phase out the open burning of agricultural material, including consideration of technical and economic factors in implementing the phase-out. The District incorporated the phase-out requirements of SB 705 into Rule 4103.

Phase-Out of Agricultural Burning

The San Joaquin Valley is the only region in California and the nation with stringent requirements to phase out agricultural open burning. Through the implementation of state law under SB 705, the District has adopted prohibitions that have significantly reduced open burning, supported by continued efforts to identify and demonstrate new alternatives to reduce open burning. As the most recent activity in this ongoing effort, the District, in collaboration with CARB, adopted a final phase-out strategy in 2021 for remaining agricultural burning by the end of 2024.[21] This strategy is supported by significant new incentive funding to help offset the high cost associated with new alternatives to burning, with enhanced focus on smaller growing operations.

Since adoption of the District's final phase-out strategy, the Valley has seen a tremendous reduction in open burning through the adoption of new practices. In 2022, the reductions in agricultural open burning and use of alternatives reached record levels for the Valley since the institution of agricultural burning restrictions. Additional

[21] SJVAPCD. *Final Supplemental Report and Recommendations on Agricultural Burning.* (June 17, 2021). Retrieved from: https://ww2.valleyair.org/media/aldmsd0b/final-supplemental-report-and-recommendations-on-agricultural-burning.pdf

requirements for smaller growers at the end of 2023 will continue to provide further reductions in open burning prior to the phase-out by the end of 2024.

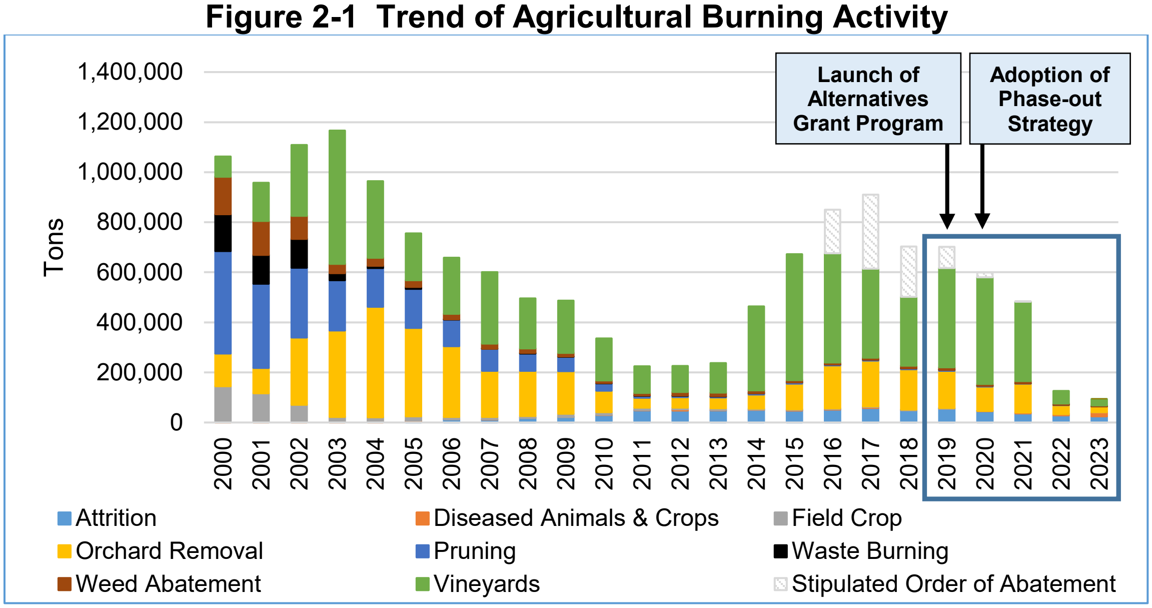
Alternatives to Open Agricultural Burning Incentive Program

To support the Valley's ongoing phase-out of agricultural open burning, in 2018, the District's Governing Board authorized the creation of the Alternatives to Agricultural Open Burning Incentive Program.[22] This program provides financial incentives to commercial agricultural operations located within the District boundaries to chip agricultural material. The chipped material is then used for soil incorporation or land application on agricultural land as an alternative to the open burning of the agricultural materials. Since 2018, the District Governing Board has allocated $25,309,504 in local District funding to this program.

On August 19, 2021, the District accepted $178,200,000 in additional state funding to be used in the District's Alternatives to Agricultural Open Burning Incentive Program.[23] This funding is the result of significant advocacy from the District and Valley agricultural stakeholders and is designated to assist the District in developing new alternative practices, increase fleet capacity for chipping in the Valley and offset the significant incremental cost of implementing new alternatives to open burning.

Overall, the program has resulted in the deployment of alternative practices at over 172,925 acres, for over 4,700,000 tons of agricultural materials, resulting in the reduction of 9,287 tons of NOx, 17,171 tons of PM and 14,503 tons of reactive organic gas (ROG) emissions.

Figure 2-1 Trend of Agricultural Burning Activity



[22] SJVAPCD. District Alternatives to Agricultural Open Burning Incentive Program. Retrieved from: https://ww2.valleyair.org/grants/ag-burn-alternatives-grant-program/

[23] SJVAPCD. *Accept and Appropriate $178,200,000 in State Funding and Approve Enhancements to Alternatives to Agricultural Open Burning Incentive Program*. (August 19, 2021). Retrieved from: https://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2021/August/final/10.pdf

Smoke Management System

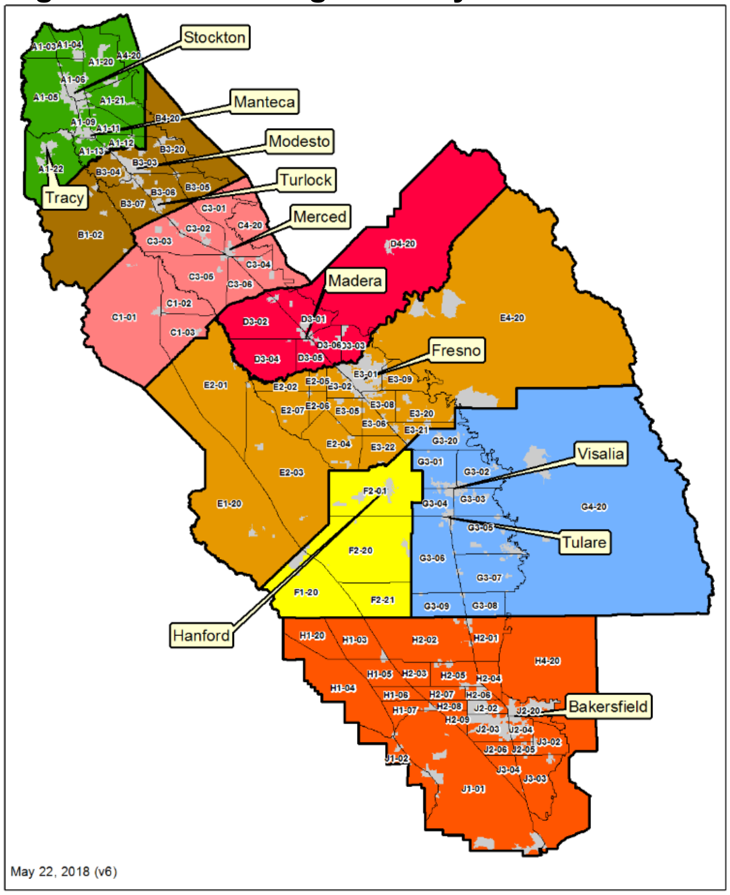
To implement SB 705 and enhance the effectiveness of the District's burn reduction efforts, in 2004, the District established the Smoke Management System (SMS), which the District uses to authorize or prohibit individual burns based on modeled smoke impacts.

Individuals requesting authorization to burn is required to complete the proper application to report the acreage, type of material, location, and date of the burn. The District uses SMS to calculate emissions by multiplying the tons of fuel burned by a crop-specific emission factor. SMS uses real-time meteorological information to analyze the impact of burning on air quality and appropriately limit burn allocations by area. The District only authorizes burns of allowable materials when the SMS emissions analysis indicates that the burn will not cause or contribute to exceedances of federal air quality standards, cause a public nuisance, or impact nearby smoke-sensitive areas. The District enforces these requirements through permits, project inspections, proactive surveillance, and complaint response.

Each year, open burning windows narrow due to unprecedented wildfires and stagnant winters with little precipitation. Open burning is strictly prohibited from November through February each year if there is an episodic residential wood burning curtailment under District Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters). These Rule 4901 curtailments are becoming increasingly frequent, with the majority of winter days now declared as No Burn days for residential wood burning, resulting in fewer agricultural open burn days each winter.

The District's SMS program divides the Valley into 97 allocation zones (see Figure 2-2 below) based on a number of criteria, such as crop distribution throughout the Valley, historical burning activities, nearby sensitive receptors, and known geographic boundaries. The amount of burning allowed in a given zone on a specific day is based on factors such as the local meteorology, air quality conditions, atmospheric holding capacity, amount of burning already approved or happening in a given area, and potential impacts on downwind populations.

Figure 2-2 Figure Smoke Management System Burn Allocation Zones



How does District Rule 4103 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Techniques Guidelines, Alternative Control Techniques, or New Source Performance Standards applicable to this source category.

State Regulations

- *CH&SC §§41850-41866 (Agricultural Burning)*
- *17 California Code of Regulations (CCR) §§80100-80330 (Smoke Management Guidelines for Agricultural and Prescribed Burning)*

The District implements the above state regulation requirements through Rule 4103. In 2003, SB 705, incorporated into CH&SC §§41855.5 and 41855.6, required the District to regulate the burning of diseased crops, establish best management practices (BMP) for the maintenance and control of weeds, and phase out the open burning for numerous crop categories. SB 705 established a schedule for specific types of agricultural material to no longer be burned in the field, but provided for a postponement of the phase-out where justified by technical and economic impediments. In addition to the requirements of CH&SC §41855.5, state law requires the District to postpone the burn prohibition dates for specific types of agricultural material if the District makes three specific determinations and CARB concurs.[24] The determinations are: (1) there are no economically feasible alternatives to open burning for that type of material; (2) open burning for that type of material will not cause or substantially contribute to a violation of an air quality standard; and (3) there is no long-term federal or state funding commitment for the continued operation of biomass facilities in the Valley or the development of alternatives to burning.

The District has complied with state requirements in preparing five reports on agricultural burning activities in the Valley since 2010. These reports have evaluated every crop category for feasible alternatives to open burning and provided recommendations for allowing or prohibiting the open burning of each crop category as outlined by SB 705. The most recent *Supplemental Report* established an updated schedule for the near-complete phase-out of remaining agricultural open burning in the Valley by January 1, 2025.

How does District Rule 4103 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4103 to comparable requirements in rules from the following California nonattainment areas:

- Bay Area AQMD Regulation 5 (Amended November 20, 2019)[25]
- Sacramento Metropolitan AQMD Rule 501 (Amended April 3, 1997)[26]
- South Coast AQMD Rule 444 (Amended July 12, 2013)[27]
- Ventura County APCD Rule 56 (Amended November 11, 2003)[28]

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4103 continues to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rule is demonstrated below.

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[24] CH&SC §41855.6

[25] BAAQMD. *Regulation 5 (Open Burning).* (Amended November 25, 2019). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/regulation-5/documents/20191120_r0500_final-pdf.pdf?la=en&rev=51124978dd4b4e598ba56bfe2a1c23df

[26] SMAQMD. *Rule 501 (Agricultural Burning).* (Amended April 3, 1997). Retrieved from: http://www.airquality.org/ProgramCoordination/Documents/rule501.pdf

[27] SCAQMD. *Rule 444 (Open Burning).* (Amended July 12, 2013). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/rule-iv/rule-444.pdf?sfvrsn=4

[28] VCAPCD. *Rule 56 (Open Burning).* (Amended November 11, 2003). Retrieved from: http://www.vcapcd.org/Rulebook/Reg4/RULE%2056.pdf

Bay Area AQMD

- BAAQMD Regulation 5 (Open Burning)

	SJVAPCD Rule 4103	BAAQMD Reg 5
Applicability	Open burning, with the exception of prescribed burning and hazard reduction burning (regulated under Rule 4106).	Open burning.
Exemption	• Fires used for cooking, campfires, and religious fires where the fuel is clean, dry wood, or charcoal • Emergency burning by a fire agency, the respectful burning of an unserviceable American flag, bags used for agricultural chemicals, and raisin trays • Specific exemptions and provisions for burning contraband and emergency agricultural burns that would cause economic loss if denied	• Fires set only for cooking of food for human beings • Fires burning as safety flares or for the combustion of waste gases • Use of flame cultivation when the burning is performed with liquefied petroleum gas (LPG) or natural gas (NG) fired burners designed and used to kill seedling grass and weeds and the growth is such that the combustion will not continue without the burner • Fires set for the purposes of fire training using one gallon or less of flammable liquid per fire • Further requirements for conditional exemptions (similar to SJV)
Requirements	No burning of garbage or other materials. Burning shall be allocated by the APCO dependent on dispersion conditions and shall avoid negative impacts to receptors. No permit shall be issued for the burning of the following categories of agricultural waste, except under specific conditions in Rule, and approved by the District Governing Board and CARB: • Field Crops • Prunings • Weed Abatement, except for categories covered by Best Management Practices in Rule • Orchard Removals • Vineyard Removal Materials • Surface Harvested Prunings • Other Materials Additional requirements for burning times, drying times, contraband burning. Permit required for the burning of Russian Thistle, and a conditional burning permit required for diseased materials with specific requirements, burn plans required for fire suppression training, burning of contraband, BMP selection required for weed maintenance.	No specific crop phase-outs or bans. Recreational fires allowed on non-curtailment days. On permissive burn days the following fires are allowed with permission from the APCO (specific requirements for each category): disease and pest, crop replacement, orchard pruning and attrition, double cropping stubble, stubble, hazardous materials (hazard reduction burning), fire training, flood debris, irrigation ditches, flood control, range management, forest management, marsh management, contraband, filmmaking, and public exhibition.

BAAQMD Regulation 5 was last amended on November 20, 2019 to reduce potential cost barriers associated with prescribed burning in alignment with statewide efforts to prevent larger, more destructive wildfires through increased prescribed burning. Specifically, the amendments include exemptions for public agencies from paying Open Burning Fees when conducting prescribed burns for the purpose of wildfire prevention. The District evaluated the requirements contained within BAAQMD's Regulation 5 and found no requirements that were more stringent than those already in Rule 4103. District Rule 4103 is as stringent as or more stringent than BAAQMD Regulation 5.

Potential Emission Reduction Opportunities

Beyond the review of current regulations and rule requirements, the District performed an extensive review of the feasibility of technologies and measures implemented in other regions and potential new technologies and measures that may be feasible for implementation in the near future. As demonstrated above, in adherence with applicable state laws instituted under SB 705, the Valley has the toughest restrictions on agricultural burning in the state. The District did not identify additional emission reduction opportunities at this time.

Evaluation Findings

The District's robust agricultural burning rule and efforts to phase out agricultural burning to date, further made more stringent with the recent action to phase out of agricultural burning by January 1, 2025, support that the District's rule is the most stringent in the nation. Therefore, Rule 4103 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.2 RULE 4104 (REDUCTION OF ANIMAL MATTER)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day						
PM2.5	0.01	0.01	0.01	0.01	0.01	0.01	0.01
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00

District Rule 4104 Description

Adopted in 1992, District Rule 4104 limits the air contaminants from operations used for the reduction of animal matter by requiring gases, vapors, and gas-entrained effluent from the process to be incinerated at temperatures not less than 1,200 degrees Fahrenheit or processed in an equally effective manner. The reduction of animal matter source category includes rendering, cooking, drying, dehydration, digesting, evaporating, and protein concentration processes.

The criteria pollutant emissions from this category are relatively small. The primary cause of concern from this source category is odor, which rule requirements minimize with the use of a venturi scrubber, cyclone, or packed bed scrubber for PM control, followed by a thermal oxidizer for VOC control. These facilities generally use steam from a boiler (indirect-fired) or rotary dryer (direct-fired) for their operations, which generate NOx emissions. The emissions from these combustion units are controlled by and accounted for in other District rules.

How does District Rule 4104 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Techniques Guidelines, Alternative Control Techniques, or New Source Performance Standards applicable to this source category.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4104 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4104 to comparable requirements in rules from the following California nonattainment areas:

- Bay Area AQMD Regulation 12, Rule 2 (Adoption Date N/A)[29]
- Monterey Bay ARD Rule 414 (Amended August 21, 2002)[30]
- Sacramento Metropolitan AQMD Rule 410 (Amended August 3, 1977)[31]
- San Diego County APCD Rule 64 (Amended August 21, 1981)[32]
- South Coast AQMD Rules 472 (Adopted May 7, 1976)[33]
- Ventura County APCD Rule 58 (Amended May 23, 1972)[34]

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4104 continues to implement requirements as stringent as or more stringent than these other areas.

Potential Emission Reduction Opportunities

Beyond the review of current regulations and rule requirements, the District performed an extensive review of the feasibility of technologies and measures implemented in other regions and potential new technologies and measures that may be feasible for implementation in the near future.

PM2.5 Emission Control Technologies

Packed Bed Scrubbers

The District evaluated the potential opportunity to reduce emissions if facilities were to replace their thermal oxidizers with packed bed scrubbers. In certain installations, packed bed scrubbers may be more efficient at removing PM from the exhaust, and additionally do not generate NOx or SOx emissions. However, retrofitting an existing facility by replacing an existing thermal oxidizer with a packed bed scrubber system may take some design and experimentation on the part of the facility to ensure it does not cause an increase in nuisance and odors or effect the operation. The retrofit costs associated with the capture and control using a packed bed scrubber would be significant. Additionally, operators would need to replace the filter media used in the

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[29] BAAQMD. *Regulation 12, Rule 2 (Rendering Plants).* (Adoption Date N/A, Approved by EPA 1981). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-12-rule-2-rendering-plants/documents/rg1202.pdf?la=en&rev=bdc8a980e3174c4b8b2f483142394f1e

[30] MBARD. *Rule 414 (Reduction of Animal Matter).* (Amended August 21, 2002). Retrieved from: https://ww2.arb.ca.gov/sites/default/files/classic/technology-clearinghouse/rules/RuleID1646.pdf

[31] SMAQMD. *Rule 410 (Reduction of Animal Matter).* (Amended August 3, 1977). Retrieved from: http://www.airquality.org/ProgramCoordination/Documents/rule410.pdf

[32] SDAPCD. *Rule 64 (Reduction of Animal Matter).* (Amended August 21, 1981). Retrieved from: https://www.sdapcd.org/content/dam/sdapcd/documents/rules/current-rules/Rule-64.pdf

[33] SCAQMD. *Rule 472 (Reduction of Animal Matter).* (Adopted May 7, 1976). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/rule-iv/rule-472.pdf?sfvrsn=4

[34] VCAPCD. *Rule 58 (Reduction of Animal Matter).* (Amended May 23, 1972). Retrieved from: http://www.vcapcd.org/Rulebook/Reg4/RULE%2058.pdf

scrubber periodically, adding to the cost of upkeep. Existing thermal oxidizer installations do not present similar issues. In addition, facilities subject to Rule 4104 produce only a very small amount of directly emitted PM2.5 and are otherwise already required to have a high level of control for emissions, as shown in the emissions inventory table at the beginning of this section.

The District did not identify additional emission reduction opportunities at this time.

Evaluation Findings

Rule 4104 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.3 RULE 4106 (PRESCRIBED BURNING AND HAZARD REDUCTION BURNING)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	4.01	6.95	4.17	4.17	4.17	4.18	4.18
NOx	0.35	0.65	0.32	0.33	0.33	0.33	0.33
	Winter Average - Tons per day						
PM2.5	3.37	8.73	2.61	2.61	2.62	2.62	2.62
NOx	0.30	0.83	0.25	0.25	0.25	0.26	0.26

District Rule 4106 Description

District Rule 4106, adopted in June 2001, is applicable to range improvement burning, forest management burning, wildland vegetation management burning, and hazard reduction burning within the Valley. Prescribed burning generally includes forest waste, fire hazard reduction, rangeland management, wildlife habitat improvement, and ecosystem (forest health) burning. The adoption of Rule 4106 incorporated provisions made necessary by the March 23, 2000 amendment of Title 17 of the California Code of Regulations. EPA approved Rule 4106 into the SIP in February 2002.[35]

Recognizing the importance of both prescribed burning and hazard reduction burning, the purpose of Rule 4106 is to permit, regulate, and coordinate the use of prescribed burning and hazard reduction burning while minimizing smoke impacts on the public. Through this rule, the District has expended considerable resources to ensure that the ignition of burn projects are only permitted when air quality and dispersion conditions are favorable, thus lessening health impacts on Valley citizens and on air quality in the Valley.

How does District Rule 4106 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Technique Guidelines, Alternative Control Techniques, or New Source Performance Standards applicable to this source category.

[35] EPA. *Revisions to the California State Implementation Plan, San Joaquin Valley Unified Air Pollution Control District*. 67 FR 8894-8897. (Codified at 40 CFR Part 52). (February 27, 2002). Retrieved from: https://www.federalregister.gov/articles/2002/02/27/02-4526/revisions-to-the-california-state-implementation-plan-san-joaquin-valley-unified-air-pollution

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4106 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4106 to comparable requirements in rules from the following California nonattainment areas:

- Bay Area AQMD Regulation 5 (Amended November 20, 2019)[36]
- Placer County APCD Rule 301 (Amended August 9, 2018)[37]
- Placer County APCD Rule 303 (Amended February 9, 2012)[38]
- Sacramento Metropolitan AQMD Rule 501 (Amended April 3, 1997)[39]
- South Coast AQMD Rule 444 (Amended July 12, 2013)[40]
- Ventura County APCD Rule 56 (Amended November 11, 2003)[41]

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4106 continues to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rules is demonstrated below.

Bay Area AQMD

- BAAQMD Regulation 5 (Open Burning)

	SJVAPCD Rule 4106	BAAQMD Regulation 5
Applicability	All prescribed burning, and hazard reduction burning in wildland/urban interface.	Open burning.
Exemptions	None.	• Fires set only for cooking of food for human beings • Fires burning as safety flares or for the combustion of waste gases • Use of flame cultivation when the burning is performed with LPG or NG-fired burners designed and used to kill seedling grass and weeds and the

[36] BAAQMD. *Regulation 5 (Open Burning).* (Amended November 20, 2019). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/regulation-5/documents/20191120_r0500_final-pdf.pdf?la=en&rev=51124978dd4b4e598ba56bfe2a1c23df
[37] PCAPCD. *Rule 301 (Nonagricultural Burning Smoke Management).* (Amended August 9, 2018). Retrieved from: https://placerair.org/DocumentCenter/View/2221/Rule-301-PDF
[38] PCAPCD. *Rule 303 (Prescribed Burning Smoke Management).* (Amended February 9, 2012). Retrieved from: https://placerair.org/DocumentCenter/View/2223/Rule-303-PDF
[39] SMAQMD. *Rule 501 (Agricultural Burning).* (Amended April 3, 1997). Retrieved from: http://www.airquality.org/ProgramCoordination/Documents/rule501.pdf
[40] SCAQMD. *Rule 444 (Open Burning).* (Amended July 12, 2013). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/rule-iv/rule-444.pdf?sfvrsn=4
[41] VCAPCD. *Rule 56 (Open Burning).* (Amended November 11, 2003). Retrieved from: http://www.vcapcd.org/Rulebook/Reg4/RULE%2056.pdf

	SJVAPCD Rule 4106	BAAQMD Regulation 5
		growth is such that the combustion will not continue without the burner • Fire training using one gallon or less of flammable liquid per fire • Further requirements for conditional exemptions (similar to SJV)
Requirements	No burning of garbage or green waste. The District shall allocate burning based on the predicted meteorological conditions and whether the total tonnage to be emitted would allow the volume of smoke and other contaminants to impact smoke sensitive areas, or create or contribute to an exceedance of an ambient air quality standard. Specific requirements for minimizing smoke, using approved ignition devices, and having vegetation be free of dirt, soil, and moisture. **Prescribed Burning:** Prescribed burn conductors shall have taken a prescribed burning smoke management training class approved by the APCO. Additional prescribed burn requirements detailed by project size. **Hazard Reduction Burning:** No Hazard Reduction Burning shall take place without a permit. A permit shall be valid only on those days during which burning is not prohibited by CARB, the District, or other designated agencies. Further administrative requirements and Smoke Management Plan requirements are outlined by project size.	Recreational fires allowed on non-curtailment days; on permissive burn days the following fires are allowed with permission from the APCO (specific requirements for each category): disease and pest, crop replacement, orchard pruning and attrition, double cropping stubble, stubble, hazardous materials (hazard reduction burning), fire training, flood debris, irrigation ditches, flood control, range management, forest management, marsh management, contraband, filmmaking, and public exhibition.

The District evaluated the requirements contained within BAAQMD's Regulation 5 and concluded that District Rule 4106 is as stringent as or more stringent than BAAQMD Regulation 5.

Placer County APCD

- PCAPCD Rule 301 (Nonagricultural Burning Smoke Management)

	SJVAPCD Rule 4106	PCAPCD Rule 301
Applicability	All prescribed burning, and hazard reduction burning in wildland/urban interface.	All burning except where otherwise prohibited by a local jurisdiction.
Exemptions	None.	• Burning conducted pursuant to rules for: agricultural waste burning, prescribed burning, land development

	SJVAPCD Rule 4106	PCAPCD Rule 301
		burning, residential allowable burning, open burning of nonindustrial wood waste at designated disposal sites • Fire hazard or health hazard burning conducted under a Public Officer waiver • Recreational or cooking fire, provided not used for waste disposal purposes • Burning, in a respectful and dignified manner, of an unserviceable American flag that is no longer fit for display • Open burning conducted by Public Officers, if conducted under other rule requirements • Burning of standing green vegetation which is part of right-of-way clearing, levee, ditch, and reservoir maintenance • APCO may grant exemption to drying times requirements if denial of such burning would threaten imminent and substantial economic loss
Requirements	No burning of garbage or green waste. The District shall allocate burning based on the predicted meteorological conditions and whether the total tonnage to be emitted would allow the volume of smoke and other contaminants to impact smoke sensitive areas, or create or contribute to an exceedance of an ambient air quality standard. Specific requirements for minimizing smoke, using approved ignition devices, and having vegetation be free of dirt, soil, and moisture. **Prescribed Burning:** Prescribed burn conductors shall have taken a prescribed burning smoke management training class approved by the APCO. Additional prescribed burn requirements detailed by project size. **Hazard Reduction Burning:** No Hazard Reduction Burning shall take place without a permit. A permit shall be valid only on those days during which burning is not prohibited by CARB, the District, or other designated agencies. Further administrative requirements and Smoke Management Plan requirements are outlined by project size.	No person shall use an open outdoor fire (including the use of a burn barrel) for the purpose of disposal or burning of any disallowed combustibles. The only allowable combustibles is vegetation originating on the premises which is reasonably free of dirt, soil, and visible surface moisture. A person shall not ignite or allow open outdoor burning without first obtaining a valid burn permit for Fire Hazard Reduction, Mechanized Burner, Open Burning Conducted by Public Officers, Right of Way Clearing, Levee, Ditch and Reservoir Maintenance, subject to burn day validity requirements. Sources must comply with preparation and drying time requirements. Burns subject to ignition devices, wind, and other requirements. Other administrative and recordkeeping requirements.

The District evaluated the requirements contained within PCAPCD Rule 301 and found that District Rule 4106 is as stringent as or more stringent than PCAPCD Rule 301.

Potential Emission Reduction Opportunities

Beyond the review of current regulations and rule requirements, the District reviewed the feasibility of technologies and measures implemented in other regions and potential new technologies and measures that may be feasible for implementation in the near future.

While there are many factors that need to be evaluated and addressed in the pursuit of minimizing fuel buildup, more effective use of prescribed burning is an area where the District has direct regulatory authority and can take action. The District has long been supportive of fuel reduction efforts including prescribed burns, advocating that reducing fuels in a responsible way will improve the health of the forests and improve future air quality by lessening the severity of wildfires. Despite these efforts, the forest fuel buildup has continued to increase at an alarming rate over the years due to decades of forest mismanagement, with fire danger being at an all-time high due to the recent catastrophic tree mortality from the drought and pest infestation. This long-term buildup of forest fuel poses a significant risk of large-scale wildfires with potential devastating impacts on air quality and public health. This has increased the need and urgency for greater forest fuel reductions. Based on direction received from the District's Governing Board in November 2015, and input from land management agencies, the District has become even more flexible when identifying permissive burn days for prescribed burning, which has assisted in a more rapid reduction of fuels. Additionally, in June 2019, the District's Governing Board authorized the District to enter into a Memorandum of Understanding (MOU) with the California Air Pollution Control Officers Association (CAPCOA) to participate in the new statewide Prescribed Burn Reporting and Monitoring Support Program in an effort to facilitate increased levels of prescribed burning across the state. These efforts have assisted in furthering the use of prescribed burning as a measure to prevent catastrophic wildfires while simultaneously minimizing health impacts for local residents.

Mechanical Removal of Forest Biomass

Given the catastrophic nature of wildfires, contradictory environmental concerns that preclude the use of mechanized equipment to dispose of fuel supplies need further examination. On one hand, there is concern that the transportation and operation of logging equipment can damage wildland ecosystems and impact endangered and threatened species, and that mechanical harvesting of vegetative fuel supplies could lead to overharvesting of the forests. On the other hand, if left unchecked, fuel buildup can lead to large wildfires that cause the destruction of the very species intended to be protected by policies such as those under the federal Wilderness Act, and in turn result in devastating public health impacts due to air pollution. The District will work with federal land managers and environmental stakeholders to ascertain the wildland areas where ecosystem and species impacts are of less concern, and support mechanical fuel reduction methods as appropriate.

The District analyzed the possibility of mechanical removal as an alternative to prescribed burning, but found that mechanical removal of forest biomass was infeasible as a required alternative to prescribed burning, due to the inaccessibility of mountain terrain and the extreme amount of forest acreage needing biomass management. However, the District will support the use of mechanical removal where feasible. Fire agencies are procuring and deploying chippers, portable saw mills, masticators and air curtain burners throughout the state, but primarily in the forested land surrounding the Valley. This process has been facilitated by emergency exemptions that have been invoked by CARB to waive the requirements for portable equipment and certain off-road equipment.

District Support of Forest-Specific Biomass Projects
The District will also explore other avenues to encourage and support forest-specific biomass projects, such as the North Fork Community Power project in Madera County. This 2 MW power plant will gasify hazard-reduction forest material, where the gas is then burned in an exhaust-controlled environment that produces very low levels of NOx. This project has been permitted and construction has commenced. The successful operation of this plant will be an important demonstration of gasification technology as a viable alternative to the open burning of forest debris. The operation of this project complements the Governor's October 30, 2015, State of Emergency Proclamation that directs state agencies to implement a number of measures to accelerate the removal of fuel in the state's forests, and which includes extending and expediting power purchase agreements with biomass facilities, seeking additional funding for biomass facilities to help offset higher feedstock costs, and exempting projects under the proclamation from California Environmental Quality Act requirements.

Due to the scale of acreage that requires management and due to access issues to remote forest areas, this is not a technologically feasible regulatory alternative to prescribed burning. However, the District will work to support forest-specific biomass projects in an effort to reduce transport emissions created from hauling forest biomass to the Valley floor for further processing.

The District did not identify additional emission reduction opportunities at this time.

Evaluation Findings

Rule 4106 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.4 RULE 4203 (PARTICULATE MATTER EMISSIONS FROM INCINERATION OF COMBUSTIBLE REFUSE)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day						
PM2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00

District Rule 4203 Description

District Rule 4203 was originally adopted on May 21, 1992, and was subsequently amended on December 17, 1992. Rule 4203 limits the concentration of PM emissions based on process weight rates, and prohibits the discharge of visible emissions from the incineration of combustible refuse. The rule applies to any person, operation, or facility who uses an incinerator or other equipment to dispose of or process combustible refuse by incineration. The only Valley facility subject to this rule currently implements BACT level requirements, using a baghouse to control particulate emissions and lime slurry dry scrubber for the control of SO2 and acid gas emissions.

How does District Rule 4203 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Technique Guidelines, Alternative Control Techniques, or New Source Performance Standards applicable to this source category.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4203 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4203 to comparable requirements in rules from the following California nonattainment areas:

- South Coast AQMD Rule 473 (Adopted May 7, 1976)[42]
- Ventura County APCD Rule 57 (Amended January 11, 2005)[43]

Bay Area AQMD and Sacramento Metropolitan AQMD do not have analogous rules for this source category.

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4203 continues to implement requirements as stringent as or more stringent than these other areas.

Potential Emission Reduction Opportunities

Beyond the review of current regulations and rule requirements, the District reviewed the feasibility of technologies and measures implemented in other regions and potential new technologies and measures that may be feasible for implementation in the near future. However, the District did not identify additional emission reduction opportunities at this time.

Evaluation Findings

Particularly since the emissions inventory for this source category is zero, Rule 4203 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

[42] SCAQMD. *Rule 473 (Disposal of Solid and Liquid Wastes).* (Adopted May 7, 1976). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/rule-iv/rule-473.pdf?sfvrsn=4

[43] VCAPCD. *Rule 57 (Incinerators).* (Amended January 11, 2005). Retrieved from: http://www.vcapcd.org/Rulebook/Reg4/RULE%2057.pdf

2.5 RULE 4204 (COTTON GINS)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	0.05	0.05	0.05	0.05	0.05	0.05	0.06
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day						
PM2.5	0.07	0.07	0.07	0.08	0.08	0.09	0.09
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00

District Rule 4204 Description

Rule 4204 was adopted on February 17, 2005, as part of the District’s strategy to reduce PM10 emissions and to attain the federal standards for the *2003 PM10 Plan*. Rule 4204 limits particulate matter emissions from cotton ginning operations. Cotton ginning is the process of separating the lint from the seed. Cotton gins have been operating within the Valley for decades and have become a highly efficient industry producing millions of bales of cotton. Modern ginning uses pneumatic conveyance, in the form of fans blowing air, which moves the cotton material throughout the ginning process. PM emissions are the unwanted byproducts of this efficient means of transferring massive quantities of cotton material from one process to the next process, such as from the unloading stage to drying and cleaning stages. Since cotton gins use large quantities of air for conveying, cyclones are used for air pollution abatement. PM emissions from cotton ginning facilities occur mostly during a three-month period from October to December.

While the principle function of the cotton gin is to separate lint from seed, the gin must also be able to remove foreign matter, moisture, and other contaminants that significantly reduce the value of the ginned lint. Currently, all cotton gins in the Valley are required to operate using high-efficiency 1D3D cyclones.

How does District Rule 4204 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Technique Guidelines, Alternative Control Techniques, or New Source Performance Standards applicable to this source category.

State Regulations

No California state regulations have been identified that are applicable to cotton gins. However, the District has identified regulations in other states that have requirements applicable to cotton gins. These include the following regulations:

- New Mexico Administrative Code (NMAC) 20.2.66.1 (Adopted April 7, 2005)[44]
- North Carolina Administrative Code (NCAC) Title 15A, Subchapter 2D, Section .0542 (Readopted November 1, 2020)[45]
- South Carolina Department of Health and Environmental Control (SCDHEC), Regulation 61-62.5, Standard No. 4, Section V (Amended September 23, 2016)[46]
- Oklahoma Department of Environmental Quality (ODEQ), Air Pollution Control, 252:100-23 (Amended June 15, 2007)[47]
- Texas Commission on Environmental Quality (TCEQ), Air Quality Standard Permit for Cotton Gin Facilities and Cotton Burr Tub Grinders (Adopted April 7, 2010)[48]

North Carolina Administrative Code Title 15A, Subchapter 2D, Section .0542 (Control of Particulate Emissions from Cotton Ginning Operations)

	SJVAPCD Rule 4204	15A NCAC 02D .0542
Applicability	All cotton ginning facilities.	All existing, new, and modified cotton ginning operations.
Exemption	Cotton ginning facilities used for research purposes and limited to throughputs of not more than 4,000 pounds of seed cotton processed per day (equivalent to 4 bales/day at a trash-to-cotton ratio of 1-to-1).	Existing facilities with a maximum rated capacity <20 bales/hour that do not have cyclones on lint cleaners and battery condensers are not required to add emission control devices to lint cleaning exhausts and/or batter condenser exhausts if emissions from the lint cleaning and/or battery condenser are controlled by fine mesh screens.
Requirements	All emission points shall be controlled by 1D3D cyclones or rotary drum filters. New cyclones or replacement parts of existing 1D3D cyclones shall have the dimensional characteristics of the Enhanced 1D3D cyclone, or the 1D3D with a 2D2D inlet and an expansion chamber trash outlet.	Control all high pressure exhausts and lint cleaning exhausts with an emission control system that includes: • One or more 1D3D or 2D2D cyclones to achieve 95% efficiency; or • A device with at least a 95% efficiency.

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[44] NMAC. *Administrative Code 20.2.66.1 (Cotton Gins).* (Adopted April 7, 2005). Retrieved from: https://www.srca.nm.gov/parts/title20/20.002.0066.html
[45] NCAC. *Administrative Code Title 15A, Subchapter 2D, Section .0542 (Control of Particulate Emissions from Cotton Ginning Operations).* (Readopted November 1, 2020). Retrieved from: https://deq.nc.gov/media/17395/download
[46] SCDHEC. *Regulation 61-62.5, Standard No. 4, Section V (Cotton Gins).* (Amended September 23, 2016). Retrieved from: https://scdhec.gov/sites/default/files/Library/Regulations/R.61-62.5_Std.4.pdf
[47] ODEQ. *Title 252, Chapter 100, Subchapter 23 (Control of Emissions from Cotton Gins).* (Amended June 15, 2007). Retrieved from: https://www.deq.ok.gov/wp-content/uploads/deqmainresources/100.pdf
[48] TCEQ. *Air Quality Standard Permit for Cotton Gin Facilities and Cotton Burr Tub Grinders.* (Adopted April 7, 2010). Retrieved from: https://www.tceq.texas.gov/assets/public/permitting/air/NewSourceReview/ag/cotton_sp_final.pdf

	SJVAPCD Rule 4204	15A NCAC 02D .0542
	Drive-under or pull-through trash collection system for load-out purposes shall not load trash into a hopper or trailer unless one or more the following are utilized: • The trash loading area has an enclosure with four sides that are higher than the trash auger; at least two sides shall be solid and the remaining sides shall: have a flexible wind barrier, which extends below the top of the trash trailer sides; or have solid doors that remain shut while trash trailers are being loaded, except as necessary to accommodate trailer movement; or have a combination of flexible wind barriers and solid doors. • A solid-sided trailer is used when there is no enclosure, and the trash auger and opening of the loading device have a flexible shroud that extends just below the top of the trailer's solid sides, or • Fugitive PM10 emissions from load-out areas are reduced by an alternative method, which is approved by the APCO and EPA. An owner/operator shall not operate a trash conveyance system dumping directly into a pile unless it meets the following requirements: • Both sides of the trash auger shall be equipped with wind barriers that extend, as measured vertically prior to trash pile build-up, one foot above and three feet below the auger or with an alternative control approved by the APCO and EPA. • After the pile has built up to the height of the trash auger, removing material from the pile shall be performed in such a way as to prevent free-falling trash from the stockpiling system. Dust management plans for facilities are subject to the requirements in District Rules 8011, 8021, 8031, 8041, 8051, 8061, 8071, and 8081.	Control all low pressure exhausts, except lint cleaning exhausts, with an emission control system that includes: • One or more 1D3D or 2D2D cyclones to achieve 90% efficiency; or • A device with at least a 90% efficiency. Minimize fugitive emissions by designing and maintaining trash systems, the gin yard, and the traffic area according to the guidelines in the regulation.

The NCAC regulation requires the use of 2D2D or 1D3D cyclones while District Rule 4204 requires 1D3D cyclones. District Rule 4204 also requires that new cyclones be Enhanced 1D3D cyclones with high control efficiency, which exceeds the standard 1D3D cyclone control efficiency. For cyclones controlling exhaust on high-pressure systems, the NCAC also specifies a 95% control efficiency. Texas A&M reports tested efficiencies of 97% for 1D3D cyclones and up to 99% for Enhanced 1D3D cyclones. Therefore, District Rule 4204 requiring the use of 1D3D cyclones on all systems, and also requiring that new cyclones be Enhanced 1D3D cyclones with PM control efficiency up to 99%, exceeds NCAC requirements for high-pressure systems with 95% PM control efficiency.

On low-pressure systems, the NCAC regulation requires the use of 2D2D or 1D3D cyclones and identifies a 90% PM control efficiency. As discussed above, District Rule 4204 requires the use of 1D3D cyclones or Enhanced 1D3D cyclones when installing new cyclones. As mentioned, Texas A&M reports tested efficiencies of 97% for 1D3D cyclones and up to 99% for Enhanced 1D3D cyclones. Therefore, District Rule 4204 requiring the use of 1D3D cyclones or new Enhanced 1D3D cyclones with PM control efficiency up to 99% exceeds NCAC requirements for low-pressure systems with 90% PM control efficiency.

The NCAC regulation also provides an exemption for operations processing less than 20 bales per hour, which could represent approximately 20,000 bales per season. Since the District rule does not have such exemption (only contains a research-targeted exemption at less than four bales/day), District Rule 4204 is more stringent in this area as well.

Therefore, overall, District Rule 4204 is more stringent than the NCAC 02D.0542 regulation applying to cotton gin operations.

South Carolina Department of Health and Environmental Control, Regulation 61-62.5, Standard No. 4, Section V (Cotton Gins)

	SJVAPCD Rule 4204	SCDHEC Reg §61-62.5.4.V
Applicability	All cotton ginning facilities.	All existing, new, and modified cotton ginning operations.
Exemption	Cotton ginning facilities used for research purposes and limited to throughputs of not more than 4,000 pounds of seed cotton processed per day (equivalent to 4 bales/day at a trash-to-cotton ratio of 1-to-1).	Existing facilities with a maximum gin stand rated capacity (or documented equipment limitation) of <20 bales/hour that do not have cyclones on lint cleaning system exhausts and battery condenser exhausts if emissions from these exhausts are controlled by fine mesh screens.
Requirements	All emission points shall be controlled by 1D3D cyclones or rotary drum filters. New cyclones or replacement parts of existing 1D3D cyclones shall have the dimensional characteristics of the Enhanced 1D3D cyclone, or the 1D3D with a 2D2D inlet and an expansion chamber trash outlet.	Each cotton ginning operation shall install and operate a particulate emission control system on all high- and low-pressure exhausts and lint cleaning system exhausts that includes one or more 1D3D or 2D2D cyclones. Trash stacker areas shall contain 1 of the following: • A 3-sided enclosure with a roof whose sides are high enough above the

	SJVAPCD Rule 4204	SCDHEC Reg §61-62.5.4.V
	Drive-under or pull-through trash collection system for load-out purposes shall not load trash into a hopper or trailer unless one or more the following are utilized: • The trash loading area has an enclosure with four sides that are higher than the trash auger; at least two sides shall be solid and the remaining sides shall: have a flexible wind barrier, which extends below the top of the trash trailer sides; or have solid doors that remain shut while trash trailers are being loaded, except as necessary to accommodate trailer movement; or have a combination of flexible wind barriers and solid doors. • A solid-sided trailer is used when there is no enclosure, and the trash auger and opening of the loading device have a flexible shroud that extends just below the top of the trailer's solid sides, or • Fugitive PM10 emissions from load-out areas are reduced by an alternative method, which is approved by the APCO and EPA. An owner/operator shall not operate a trash conveyance system dumping directly into a pile unless it meets the following requirements: • Both sides of the trash auger shall be equipped with wind barriers that extend, as measured vertically prior to trash pile build-up, one foot above and three feet below the auger or with an alternative control approved by the APCO and EPA. • After the pile has built up to the height of the trash auger, removing material from the pile shall be performed in such a way as to prevent free-falling trash from the stockpiling system. Dust management plans for facilities are subject to the requirements in District Rules 8011, 8021, 8031, 8041, 8051, 8061, 8071, and 8081.	opening of the dumping device to prevent wind from dispersing dust or debris; or • A device to provide wet suppression at the dump area of the trash cyclone and minimize free fall distance of waste material exiting the trash cyclone. Minimize fugitive emissions by designing and maintaining trash systems, the gin yard, and the traffic area according to the guidelines in the regulation.

The SCDHEC regulation requires the use of 2D2D or 1D3D cyclones, while District Rule 4204 requires 1D3D cyclones and requires that new cyclones be Enhanced 1D3D cyclones with high control efficiency. Texas A&M reports tested efficiencies of 97% for 1D3D cyclones and up to 99% for Enhanced 1D3D cyclones. Therefore, District Rule

4204 requirements result in higher PM control efficiency as compared to SCDHEC regulation requirements.

The SCDHEC regulation also provides an exemption for operations processing less than 20 bales per hour, which could represent approximately 20,000 bales per season. Since the District rule does not have such an exemption, District Rule 4204 is more stringent in this area as well.

While the SCDHEC regulation requires the trash stacker be contained in a three-sided enclosure, District Rule 4204 requires that the trash loading area be an enclosure with four sides higher than the trash auger, which is more stringent.

Therefore, District Rule 4204 is more stringent than the SCDHEC Regulation 62.5, Std. 4, Section V requirements applying to cotton gin operations.

How does District Rule 4204 compare to rules in other air districts?

Bay Area AQMD, Sacramento Metropolitan AQMD, South Coast AQMD, and Ventura County APCD do not have analogous rules for this source category.

Potential Emission Reduction Opportunities

Beyond the review of current regulations and rule requirements, the District reviewed the feasibility of technologies and measures implemented in other regions and potential new technologies and measures that may be feasible for implementation in the near future.

PM2.5 Emission Control Technologies

Baghouses

The District evaluated baghouses as a potential control device, however, these technologies are generally not feasible for cotton ginning operations due to a number of factors. A typical cotton ginning operation relies on an air cleaning system handling fibrous materials such as cotton and cotton waste in a cotton gin. This air cleaning system uses high volumes of air to move the cotton throughout the ginning operation. Usually, these high volumes of air are much higher than any volumes of air passing through a baghouse. Throughout the various processes of the cotton gin operation, air velocities range from 1,500 ft/min to 5,000 ft/min.[49] Higher-than-average gas volumes and PM cause bag blinding,[50] where the increased velocity allows dust to penetrate into the fabric, and the cleaning system is unable to remove it.

In addition to the high volume of air, the baghouse would also see higher than normal temperature excursions, which can shorten bag life considerably. This same effect occurs when seed cotton is first dried in large dryers using heated air to reduce

[49] Reference Agriculture Handbook No. 503 – Cotton Ginners Handbook, July 1977, page 59.
[50] Blinding (*define*) – A closing of the filter medium pores which results in either a reduced gas flow or an increased pressure drop across the medium.

moisture content, and if the seed cotton requires additional drying, it is often run through a second or third dryer.

Excess moisture is common to cotton grown in the more humid regions of the Cotton Belt, while cotton produced in the Southwest can be too dry because of the region's arid climate. Lack of moisture at ginning can lower the quality of the fiber and contribute to ginning problems. For these reasons, moisture is added with a special humidifier that blows warm, humid air through the gin's conveyor pipes. Moisture on the bags tends to alter the adhesion of the dust cake on and within the fabric structure, and "mudding" or blinding of the bags may occur because the cleaning system cannot remove this dust.

The District determined that due to the requirements for high volumes of air, blinding from the fibrous material, temperature excursions across fabric filters, and introduction of moisture during the ginning operation, baghouses would not be a feasible control device for cotton ginning operations.

1D3D Cyclones with Expansion Chamber

Currently, all cotton gins in the Valley are required to operate using a 1D3D cyclone. There are currently 28 such units, and about two thirds of the 1D3D cyclones used in the Valley have an expanded chamber outlet. Research has shown that an expansion chamber allows for more air flow since it is not as narrow. In initial tests, a larger D/3 size expanded chamber exit produced PM10 emissions that were about 8% lower than those resulting from use of the standard, small-diameter (D/4) exit.[51] A USDA study[52] on PM2.5 emissions from cotton gins provided a PM2.5/PM10 ratio for emissions from cotton gins, however did not extend to the expected PM2.5 control efficiencies of control devices at cotton gins; the District has found no completed research indicating the effectiveness of reducing PM2.5 by installing an expansion chamber. As noted above, expansion chambers result in a minor increase in efficiency for PM10 emissions control, but PM2.5 is a very small fraction of the overall particulate in these systems and does not respond as well as PM10 to air flow changes, such as those induced by an expansion chamber. Therefore, expansion chambers would not be a feasible control for PM2.5.

Mechanical Conveyance

The District considered mechanical conveyance for the main trash handling system as a potential opportunity to reduce emissions, however it has only been demonstrated as feasible for newly constructed or rebuilt cotton gins. Mechanical conveyance reduces emissions from cotton gin trash handling exhaust streams, which are otherwise moved pneumatically. The cotton gin trash handling systems only comprise a fraction of the emissions that are released from the full cotton ginning process.

Newer or rebuilt cotton gins are able to accommodate a mechanical conveyance system since operators are able to design the cotton gin around the equipment and space

[51] Baker R.V. and Hughs S.E. (1998). Influence of Air Inlet and Outlet Design and Trash Exit Size on 1D3D Cyclone Performance. Transactions of the ASAE, vol. 42(1): 17-21.
[52] USDA, Agricultural Research Service. *Characterization of Cotton Gin Particulate Matter Emissions.* (2013). Retrieved from: http://buser.okstate.edu/air-quality/cotton-gin/national-study/

needed. Operators that have installed a mechanical conveyance system for their cotton gin have had to build a lower floor, below the main level containing the major cotton gin equipment, to house the mechanical conveyors. Therefore, as confirmed by equipment manufacturers, it is not technologically feasible to retrofit existing cotton gins with mechanical conveyance systems to replace existing trash handling equipment.

Based on this review, the District did not identify additional emission reduction opportunities at this time.

Evaluation Findings

Rule 4204 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.6 RULE 4301 (FUEL BURNING EQUIPMENT)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NOx	n/a	n/a	n/a	n/a	n/a	n/a	n/a
	Winter Average - Tons per day						
PM2.5	n/a	n/a	n/a	n/a	n/a	n/a	n/a
NOx	n/a	n/a	n/a	n/a	n/a	n/a	n/a

The emission inventory is not specific to Rule 4301. See Rules 4306, 4307, 4308, 4309, and 4352 for the individual emissions inventories.

District Rule 4301 Description

District Rule 4301 applies to all types of fuel burning equipment, except air pollution control equipment. The purpose of this rule is to limit emissions of air contaminants from fuel burning equipment by specifying maximum emission rates for SOx, NOx, and PM (identified in the rule as combustion contaminant emissions). EPA finalized approval of the 1992 amendments to Rule 4301 on May 18, 1999.

Rule 4301 limits the concentration of combustion contaminants to 0.1 grain per standard cubic feet of gas and limits maximum emissions rates of SOx to 200 pounds per hour, NOx to 140 pounds per hour, and combustion contaminants to 10 pounds per hour from fuel burning equipment.

Rule 4301 has a very broad applicability, as it applies to all types of fuel burning equipment. Several District rules with more stringent NOx requirements for specific types of fuel burning equipment supersede this rule. See the control measure evaluations for Rules 4306, 4307, 4308, 4309, 4320, and 4352 for more specific information about the individual fuel burning equipment source categories.

How does District Rule 4301 compare with federal and state rules and regulations?

Facilities subject to Rule 4301 are subject to various state rules and federal requirements. However, several District rules have superseded Rule 4301 with more stringent requirements. The control measure evaluations for those rules include comparisons of those District rules to the applicable federal and state regulations.

How does District Rule 4301 compare to rules in other air districts?

Several District rules with more stringent NOx requirements for specific types of fuel burning equipment supersede this rule. See Rules 4306, 4307, 4308, 4309, 4320, and 4352 for comparisons of those rules to applicable rules in other air districts.

Potential Emission Reduction Opportunities

Several District rules with more stringent requirements have superseded Rule 4301. The control measure evaluations for those rules discuss any potential emission reduction opportunities for this source category.

Evaluation Findings

Several District rules with more stringent NOx requirements for specific types of fuel burning equipment supersede this rule. These rules satisfy and go beyond BACM for fuel burning equipment. See the control measure evaluations for Rules 4306, 4307, 4308, 4309, 4320, and 4352.

2.7 RULE 4306 AND 4320 (BOILERS, STEAM GENERATORS, AND PROCESS HEATERS, GREATER THAN 5.0 MMBTU/HR)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	2.39	2.28	2.13	2.01	1.90	1.83	1.80
NOx	3.53	3.29	2.94	2.44	2.19	2.03	1.96
	Winter Average - Tons per day						
PM2.5	2.35	2.25	2.09	1.97	1.86	1.79	1.76
NOx	3.42	3.19	2.85	2.36	2.11	1.95	1.88

District Rules 4306 and 4320 Description

Rules 4306 and 4320 apply to any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input greater than 5 million British thermal units per hour (MMBtu/hr). The purpose of these rules is to limit emissions from boilers, steam generators, and process heaters of this size range. Facilities with units subject to these rules represent a wide range of industries, including but not limited to electrical utilities, cogeneration, oil and gas production, petroleum refining, manufacturing and industrial processes, food and agricultural processing, and service and commercial facilities.

The purpose of Rule 4306 is to limit emissions of NOx and carbon monoxide (CO) from applicable units. Rule 4320 establishes more stringent limits for NOx, CO, oxides of sulfur (SO2), and PM10, and provides Advanced Emission Reduction Options for rule compliance, where an operator can either meet the specific NOx emission and PM control requirements, or pay an annual emissions fee to the District and meet the PM control requirements.

The District Governing Board adopted amendments to Rules 4306 and 4320 on December 17, 2020, to reduce emissions from boilers, process heaters, and steam generators in the Valley. These amendments were based on a comprehensive technical analysis, in-depth review of local, state, and federal regulations, and a robust public process. Modifications to Rules 4306 and 4320 included lowering NOx emissions limits for a variety of unit classes and categories, and establishing dates for emission control plans, authorities to construct, and compliance deadlines. Additionally, the District updated the unit categories in Rule 4306 to account for differences in technologically achievable and cost effective limits, which vary between different types and sizes of units. Updated category groupings also establish consistency in the categories included in Rule 4306 as well as Rule 4320. The District also added definitions and updated test methods in Rules 4306 and 4320 to improve clarity, and reflect changes to rule requirements and the latest version of test methodology available.

In situations where a retrofit may not be the best option given the technology forcing nature of the limits, operators have the option of paying an annual emissions fee based on the actual emissions of the unit during the previous calendar year while the facility continually evaluates the feasibility of potential controls. These fees may then be used by the District to support cost effective emission reductions and other pollution reduction activities. Fees would be paid annually and continue until the unit complies with the applicable limit. The affected sources will have the option, on an annual basis, to stop the fee option and install controls specified in the rule. The amended Rules 4306 and 4320 include the most effective controls that are available and technologically feasible, and are the most stringent regulations in the country for the subject type of units.

How do District Rules 4306 and 4320 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Techniques Guidelines applicable to this source category.

A. Alternative Control Techniques (ACT)

- *Alternative Control Techniques Document – NOx Emissions from Process Heaters (EPA-453/R-93-034 1993/09)*

The District evaluated the requirements contained within the ACT for NOx Emissions from Process Heaters and found no requirements that were more stringent than those already in Rules 4306 and 4320.

- *Alternative Control Techniques Document – NOx Emissions from Industrial/Commercial/Institutional Boilers (EPA-453/R-94-022 1994/03)*

The District evaluated the requirements contained within the ACT for NOx Emissions from Industrial/Commercial/Institutional Boilers and found no requirements that were more stringent than those already in Rules 4306 and 4320.

- *Alternative Control Techniques Document – NOx Emissions from Utility Boilers (EPA-453/R-94-023 1994/03)*

The District evaluated the requirements contained within the ACT for NOx Emissions from Utility Boilers and found no requirements that were more stringent than those already in Rules 4306 and 4320.

B. New Source Performance Standards (NSPS)

- *40 CFR 60 Subpart D – Standards of Performance for Fossil-Fuel Fired Steam Generators (2007/06)*

The District evaluated the requirements contained within 40 CFR 60 Subpart D and found no requirements that were more stringent than those already in Rules 4306 and 4320.

- *40 CFR 60 Subpart Db – Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units (2007/06)*

The District evaluated the requirements contained within 40 CFR 60 Subpart Db and found no requirements that were more stringent than those already in Rules 4306 and 4320.

- *40 CFR 60 Subpart Dc – Standards of Performance for Small Industrial-Commercial-Institutional Steam Generating Units (2012/04)*

The District evaluated the requirements contained within 40 CFR 60 Subpart Dc and found no requirements that were more stringent than those already in Rules 4306 and 4320.

State Regulations

There are no state regulations applicable to this source category.

How do District Rules 4306 and 4320 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rules 4306 and 4320 to comparable requirements in rules from the following nonattainment areas:

- Bay Area AQMD Regulation 9, Rule 7 (Amended May 4, 2011)[53]
- Bay Area AQMD Regulation 9, Rule 10 (Amended November 3, 2021)[54]
- Bay Area AQMD Regulation 9, Rule 11 (Amended May 17, 2000)[55]

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[53] BAAQMD. *Regulation 9, Rule 7 (Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters)*. (Amended May 4, 2011). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-7-nitrogen-oxides-and-carbon-monoxide-from-industrial-institutional-and-commercial-boiler/documents/rg0907.pdf?la=en&rev=ab95f36c2dd146528f1cf3c10596bce3

[54] BAAQMD. *Regulation 9, Rule 10 (Nitrogen Oxides and Carbon Monoxide from Boilers, Steam Generators, and Process Heaters in Petroleum Refineries).* (Amended November 3, 2021). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/refinery-rules-definitions/rg0910_20211103-pdf.pdf?la=en&rev=6e3872940d924000b45ea05f05b5a309

[55] BAAQMD. *Regulation 9, Rule 11 (Nitrogen Oxides and Carbon Monoxide from Utility Electric Power Generating Boilers)*. (Amended May 17, 2000). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-

- Sacramento Metropolitan AQMD Rule 411 (Amended August 23, 2007)[56]
- South Coast AQMD Rule 1146 (Amended December 4, 2020)[57]
- South Coast AQMD Rule 1109.1 (Adopted November 5, 2021)[58]
- Ventura County APCD Rule 74.15 (Amended November 10, 2020)[59]

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rules 4306 and 4320 continue to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rules is demonstrated below.

Bay Area AQMD

- BAAQMD Regulation 9, Rule 10 (Boilers, Steam Generators and Process Heaters in Refineries)

BAAQMD amended Regulation 9, Rule 10 on November 3, 2021. The 2021 amendments were administrative and did not affect the stringency of rule requirements implemented prior to EPA's approval of the District meeting BACM/MSM for the *2018 PM2.5 Plan*. The District found no requirements in BAAQMD Regulation 9, Rule 10 that were more stringent than those in Rules 4306 and 4320.

South Coast AQMD

- SCAQMD Rule 1146 (Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters)

	SJVAPCD Rules 4306 and 4320	SCAQMD Rule 1146
Applicability	Any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input >5 MMBtu/hr.	Boilers, steam generators, and process heaters of ≥5 MMBtu/hr rated heat input capacity used in industrial, institutional, and commercial operations.
Exemptions	• Units regulated by other District rules such as solid fuel fired units, dryers, glass melting furnaces, kilns, and smelters • Any units while burning any fuel other than PUC quality natural gas that: o Burns non-PUC gas no more than 168 hr/yr plus 48 hr/yr for equipment testing o NOx emissions do not exceed 150 ppm	• Boilers used by electric utilities to generate electricity • Boilers and process heaters with a rated heat input capacity >40 MMBtu/hr that are used in petroleum refineries • Sulfur plant reaction boilers

11-nitrogen-oxides-and-carbon-monoxide-from-utility-electric-power-generating-boilers/documents/rg0911.pdf?la=en&rev=cf79907f652d454c9b52a55ae3e95903

[56] SMAQMD. *Rule 411 (NOx from Boilers, Process Heaters, and Steam Generators).* (Amended August 23, 2007). Retrieved from: http://www.airquality.org/ProgramCoordination/Documents/rule411.pdf

[57] SCAQMD. *Rule 1146 (Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters).* (Amended December 4, 2020). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1146.pdf

[58] SCAQMD. *Rule 1109 (Emissions of Oxides of Nitrogen from Petroleum Refineries and Related Operations).* (Amended December 4, 2020). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1109-1.pdf?sfvrsn=8

[59] VCAPCD. *Rule 74.15 (Boilers, Steam Generators, and Process Heaters).* (Amended November 10, 2020). Retrieved from: http://www.vcapcd.org/Rulebook/Reg4/RULE%2074.15.pdf

	SJVAPCD Rules 4306 and 4320		SCAQMD Rule 1146
Requirements	**Rule 4306**	**Rule 4320**	
Category A Units 5-20 MMBtu/hr Except Categories C through G units	7 ppmv for fire tube units 9 ppmv for all other units	5 ppmv for fire tube units 9 ppmv for units at schools, units fired on digester gas, and thermal fluid heaters 5 ppmv for all other units	Non-RECLAIM 7 ppmv for fire tube units 9 ppmv for all other units RECLAIM 9 ppmv for fire tube units 12 ppmv for all other units
Category B Units >20 MMBtu/hr Except Categories C through G units	20-75 MMBtu/hr: 7 ppmv ≥75 MMBtu/hr: 5 ppmv	2.5 ppmv	20-75 MMBtu/hr: Non-RECLAIM 7 ppmv for fire tube units 9 ppmv (units with previous NOx limit ≤12 and >5 ppmv prior to 12/7/18) 5 ppmv (all other units) RECLAIM 9 ppmv for fire tube units 12 ppmv for all other units ≥75 MMBtu/hr: Non-RECLAIM: 5 ppmv RECLAIM: 9 ppmv
Category C.1 Oilfield Steam Generators 5-20 MMBtu/hr	9 ppmv	6 ppmv	SCAQMD Rule 1146 applies to Industrial, Institutional, and Commercial Units. Oilfield steam generators do not fall into these categories per definitions in the rule.
Category C.2 Oilfield Steam Generators 20-75 MMBtu/hr	9 ppmv	5 ppmv	
Category C.3 Oilfield Steam Generators >75 MMBtu/hr	7 ppmv	5 ppmv	
Category C.4 Oilfield Steam Generators fired on <50% PUC quality gas	15 ppmv	5 ppmv	
Category D.1 Refinery Boilers 5-40 MMBtu/hr	30 ppmv 5 ppmv for replacement units	5 ppmv	SCAQMD Rule 1146 applies to Industrial, Institutional, and Commercial Units. Petroleum Refineries do not fall into these categories per definitions in the rule.
Category D.2 Refinery Boilers 40-110 MMBtu/hr	9 ppmv 5 ppmv for replacement units	5 ppmv	
Category D.3 Refinery Boilers >110 MMBtu/hr	5 ppmv	2.5 ppmv	
Category D.4 Refinery Process Heaters 5-40 MMBtu/hr	30 ppmv 9 ppmv for replacement units	5 ppmv	

	SJVAPCD Rules 4306 and 4320		SCAQMD Rule 1146
Category D.5 Refinery Process Heaters 40-110 MMBtu/hr	15 ppmv 9 ppmv for replacement units	5 ppmv	
Category D.6 Refinery Process Heaters >110 MMBtu/hr	5 ppmv	2.5 ppmv	
Category E Units with annual heat input >1.8 billion Btu/yr but <30 billion Btu/yr	No NOx limits for units ≤9 billion Btu/yr, must tune up twice a year. Other units: 30 ppmv	9 ppmv	No NOx limits for units ≤9 billion Btu/yr, must tune up twice a year. Other units would be subject to applicable category limits in rule.
Additional Categories Included in SCAQMD Rule 1146			
Atmospheric Units These units would be subject to the limits in Category A or B in District Rules	Category A 7 ppmv fire tube boilers 9 ppmv other units Category B 20-75 MMBtu/hr: 7 ppmv >75 MMBtu/hr: 5 ppmv enhanced	Category A 5 ppmv for fire tube units 9 ppmv for units at schools, units fired on digester gas, and thermal fluid heaters 5 ppmv for all other units Category B 2.5 ppmv	12 ppmv (natural gas)
Digester gas These units would be subject to the limits in Category A or B in District Rules			15 ppmv
Landfill gas These units would be subject to the limits in Category A or B in District Rules			25 ppmv
Other units fired on gaseous fuel Covered under multiple categories in District Rules			30 ppmv

The District evaluated the requirements contained within SCAQMD's Rule 1146 and the District concludes that overall the requirements in Rules 4306 and 4320 are as stringent as or more stringent than SCAQMD Rule 1146.

- SCAQMD Rule 1109.1 (Emissions of Oxides of Nitrogen from Petroleum Refineries and Related Operations)

	SJVAPCD Rules 4306 and 4320		SCAQMD Rule 1109.1
Applicability	Any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input >5 MMBtu/hr.		Owners or operators of facilities with units at petroleum refineries and facilities with related operations to petroleum refineries.
Exemptions	• Units regulated by other District rules such as solid fuel fired units, dryers, glass melting furnaces, kilns, and smelters. • Any units while burning any fuel other than PUC quality natural gas that: ○ Burns non-PUC gas no more than 168 hr/yr plus 48 hr/yr for equipment testing ○ NOx emissions do not exceed 150 ppm		• Boilers or process heaters ≤2 MMBtu/hr • Boilers and process heaters with a rated heat input capacity <40 MMBtu/hr that operate <200 hr/yr • Boilers and process heaters with a rated heat input capacity <40 MMBtu/hr that are fired at <15% maximum rated heat input capacity per year • Boilers or process heaters operating only the pilot prior to startup or after shutdown
Requirements	**Rule 4306**	**Rule 4320**	
Category A Units 5-20 MMBtu/hr Except Categories C through G units	7 ppmv for fire tube units 9 ppmv for all other units	5 ppmv for fire tube units 9 ppmv for units at schools, units fired on digester gas, and thermal fluid heaters 5 ppmv for all other units	SCAQMD Rule 1109.1 only applies to units at petroleum refineries
Category B Units >20 MMBtu/hr Except Categories C through G units	20-75 MMBtu/hr: 7 ppmv ≥75 MMBtu/hr: 5 ppmv	2.5 ppmv	SCAQMD Rule 1109.1 only applies to units at petroleum refineries
Category C.1 Oilfield Steam Generators 5-20 MMBtu/hr	9 ppmv	6 ppmv	SCAQMD Rule 1109.1 only applies to units at petroleum refineries
Category C.2 Oilfield Steam Generators 20-75 MMBtu/hr	9 ppmv	5 ppmv	
Category C.3 Oilfield Steam Generators >75 MMBtu/hr	7 ppmv	5 ppmv	
Category C.4 Oilfield Steam Generators fired on <50% PUC quality gas	15 ppmv	5 ppmv	
Category D.1 Refinery Boilers 5-40 MMBtu/hr	30 ppmv 5 ppmv for replacement units	5 ppmv	40 ppmv 5 ppmv after burner replacement

	SJVAPCD Rules 4306 and 4320		SCAQMD Rule 1109.1
Category D.2 Refinery Boilers 40-110 MMBtu/hr	9 ppmv 5 ppmv for replacement units	5 ppmv	Limits ranging from 5-50 ppmv due to conditional limits, interim limits, and alternative compliance options
Category D.3 Refinery Boilers >110 MMBtu/hr	5 ppmv	2.5 ppmv	Limits ranging from 5-50 ppmv due to conditional limits, interim limits, and alternative compliance options
Category D.4 Refinery Process Heaters 5-40 MMBtu/hr	30 ppmv 9 ppmv for replacement units	5 ppmv	40 ppmv 9 ppmv after replacement of burners
Category D.5 Refinery Process Heaters 40-110 MMBtu/hr	15 ppmv 9 ppmv for replacement units	5 ppmv	Limits ranging from 5-50 ppmv due to conditional limits, interim limits, and alternative compliance options
Category D.6 Refinery Process Heaters >110 MMBtu/hr	5 ppmv	2.5 ppmv	Limits ranging from 5-22 ppmv due to conditional limits, interim limits, and multiple alternative compliance options
Category E Units with annual heat input >1.8 billion Btu/yr but <30 billion Btu/yr	No NOx limits for units ≤9 billion Btu/yr, must tune up twice a year. Other units: 30 ppmv	9 ppmv	No NOx limit for boilers and process heaters with rated heat input capacity <40 MMBtu/hr that operate <200 hr/yr, or are fired <15% maximum rated heat input capacity per year

SCAQMD Rule 1109.1 has NOx emission limits for some categories of refinery units that could be seen as being more stringent than District Rule 4306. However, for these categories of units, SCAQMD Rule 1109.1 has higher conditional limits, higher interim limits, and multiple alternative compliance options are available, thus making the NOx limits less stringent than the firmly established NOx limits in Rule 4306. Additionally, Rule 4320 contains limits as stringent as or more stringent than limits in SCAQMD Rule 1109.1. The District concludes that overall Rules 4306 and 4320 are as stringent as or more stringent than SCAQMD Rule 1109.1.

Ventura County APCD

- VCAPCD Rule 74.15 (Boilers, Steam Generators, and Process Heaters)

	SJVAPCD Rules 4306 and 4320	VCAPCD Rule 74.15
Applicability	Any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input >5 MMBtu/hr.	Boilers, steam generators and process heaters, >5 MMBtu/hr used in all industrial, institutional and commercial operations.
Exemptions	• Units regulated by other District rules such as solid fuel fired units, dryers, glass melting furnaces, kilns, and smelters • Any units while burning any fuel other than PUC quality natural gas that: o Burns non-PUC gas no more than 168 hr/yr plus 48 hr/yr for equipment testing o NOx emissions do not exceed 150 ppm	• Units fired on alternate fuel during natural gas curtailment • Emergency standby units • Cold Startup

	SJVAPCD Rules 4306 and 4320		VCAPCD Rule 74.15
Requirements	**Rule 4306**	**Rule 4320**	
Category A Units 5-20 MMBtu/hr Except Categories C through G units	7 ppmv for fire tube units 9 ppmv for all other units	5 ppmv for fire tube units 9 ppmv for units at schools, units fired on digester gas, and thermal fluid heaters 5 ppmv for all other units	40 ppmv After Jan. 1, 2027: 9 ppmv for boilers 12 ppmv for process heaters
Category B Units >20 MMBtu/hr Except Categories C through G units	20-75 MMBtu/hr: 7 ppmv ≥75 MMBtu/hr: 5 ppmv	2.5 ppmv	40 ppmv After Jan. 1, 2027: 9 ppmv for boilers 12 ppmv for process heaters
Category C.1 Oilfield Steam Generators 5-20 MMBtu/hr	9 ppmv	6 ppmv	40 ppmv After Jan. 1, 2027: 9 ppmv
Category C.2 Oilfield Steam Generators 20-75 MMBtu/hr	9 ppmv	5 ppmv	
Category C.3 Oilfield Steam Generators >75 MMBtu/hr	7 ppmv	5 ppmv	
Category C.4 Oilfield Steam Generators fired on <50% PUC quality gas	15 ppmv	5 ppmv	
Category D.1 Refinery Boilers 5-40 MMBtu/hr	30 ppmv 5 ppmv for replacement units	5 ppmv	40 ppmv After Jan. 1, 2027: 9 ppmv
Category D.2 Refinery Boilers 40-110 MMBtu/hr	9 ppmv 5 ppmv for replacement units	5 ppmv	40 ppmv After Jan. 1, 2027: 9 ppmv
Category D.3 Refinery Boilers >110 MMBtu/hr	5 ppmv	2.5 ppmv	40 ppmv After Jan. 1, 2027: 9 ppmv
Category D.4 Refinery Process Heaters 5-40 MMBtu/hr	30 ppmv 9 ppmv for replacement units	5 ppmv	40 ppmv After Jan. 1, 2027: 12 ppmv
Category D.5 Refinery Process Heaters 40-110 MMBtu/hr	15 ppmv 9 ppmv for replacement units	5 ppmv	40 ppmv After Jan. 1, 2027: 12 ppmv

	SJVAPCD Rules 4306 and 4320		VCAPCD Rule 74.15
Category D.6 Refinery Process Heaters >110 MMBtu/hr	5 ppmv	2.5 ppmv	40 ppmv After Jan. 1, 2027: 12 ppmv
Category E Units with annual heat input >1.8 billion Btu/yr but <30 billion Btu/yr	No NOx limits for units ≤9 billion Btu/yr, must tune up twice a year. Other units: 30 ppmv	9 ppmv	No NOx limits for units <9 billion Btu/yr, must tune up twice a year. Other units: 40 ppmv After Jan. 1, 2027: 9-30 billion Btu/yr: 9 ppmv for boilers 12 ppmv for process heaters

The District evaluated the requirements contained within VCAPCD's Rule 74.15 and the District concludes that overall Rules 4306 and 4320 are as stringent as or more stringent than VCAPCD Rule 74.15.

Potential Emission Reduction Opportunities

Beyond the review of current regulations and rule requirements, the District reviewed the feasibility of technologies and measures implemented in other regions and potential new technologies and measures that may be feasible for implementation in the near future.

NOx Emission Control Technologies

The two primary methods of controlling NOx emissions from boilers, steam generators, and process heaters are either to change the combustion parameters (i.e., combustion modification) to reduce NOx formation, or to treat the NOx formed before it is emitted into the atmosphere with the use of selective catalytic reduction (SCR).

Through SCR, NOx is reduced to molecular nitrogen by adding a flue gas treatment system consisting of a catalyst module and a reagent injection system located after the boiler firebox. SCR units operate at a certain temperature range to effectively reduce NOx in the exhaust gas by injecting either ammonia stored in aqueous form, anhydrous form, generated on demand, or released from urea into the post-combustion zone of the boiler. SCR systems are generally paired with low-NOx burners (LNB).

While many operations have successfully installed SCR and other latest generation control systems through Rule 4306/4320 implementation and New Source Review BACT requirements, these control technologies have not yet been proven to be technologically feasible and cost effective as retrofit options for all source categories and applications, such as oilfield steam generators. For many facilities, this technology is not an option due to space constraints and other physical limitations.

SCR has significant initial capital costs, requires large footprints that impact other operations (resulting in significant additional costs), and requires additional construction costs to accommodate the large size of the catalyst and the storage of the injection reagent (such as anhydrous ammonia). The temperature required for SCR units to function effectively (400-800 °F) in relation to existing exhaust temperatures (i.e. ~250 °F for oilfield steam generators) poses significant and potentially insurmountable feasibility and cost challenges to operators. For example, in many situations, steam generators would have to be cut open to retrofit an SCR unit into the convection section of the steam generator to operate the SCR system at the correct temperature. This would cause heat loss, preventing the production of the steam necessary for the oil field operation.

The District is already requiring the most stringent feasible NOx controls, exceeding BACM requirements. Therefore, no additional NOx control requirements are feasible for this source category at this time.

PM2.5 Emission Control Technologies

Baghouses (Pulse Jet[60]/Reverse Air,[61] Ceramic Dust Collectors[62])
Baghouses force exhaust through filters which capture PM by impingement. Filter media may be cloth/paper bags, pleated cloth in cartridge form, or even packed ceramic media within cages. Per EPA fact sheets for this technology, Cloth/paper filters can only control filterable PM. Per manufacturer data, ceramic media can only provide limited control (≤20%) of condensable PM.

Wet[63]/Dry[64] Electrostatic Precipitators
Electrostatic Precipitators (ESPs) use ionized gas and/or electromagnetic field to impart static charge to particles in the exhaust stream which are then attracted to collection plates held at high voltage. To clean the collection plates, dry ESPs use mechanical or acoustical methods, while wet ESPs use wash liquid. Per EPA fact sheets for this technology, dry ESPs can only control filterable PM and can have difficulty collecting particles with an aerodynamic diameter of 0.1 to 1 micron. Since all of the PM from NG-fuel combustion is assumed to be less than 1 micron in size, the PM2.5 control efficiency of a dry ESP is assumed to be 90%. Particle size is less of a factor for wet ESPs, however capital and operating costs are generally higher due to noncorrosive materials requirements, increased water usage, and treatment and disposal of waste water.

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[60] EPA-452/F-03-025 https://www3.epa.gov/ttnchie1/mkb/documents/ff-pulse.pdf
[61] EPA-452/F-03-026 https://www.epa.gov/sites/default/files/2020-10/documents/ff-revar.pdf
[62] Correspondence from Clean Air Systems
[63] EPA-452/F-03-029 https://www3.epa.gov/ttn/chief/mkb/documents/fwespwpi.pdf#:~:text=An%20ESP%20is%20a%20particulate%20%20control%20device%20that,effluent%20is%20collected%2C%20andoften%20treated%20on-%20site%20%28EPA%2C%201998%29
[64] EPA-452/F-03-027 https://www3.epa.gov/ttn/catc/dir1/fdespwpi.pdf

Venturi Scrubbers[65]

Venturi scrubbers introduce an atomized liquid into the exhaust stream upon which PM agglomerates. The liquid mist is subsequently removed by cyclonic separator and/or mist eliminator. Venturi Scrubbers require high differential pressure (20 to 24 inches water column) which may require additional fans.

Table 2-2 Typical Applications of Control Technologies

Control Technology	Recommended Inlet Loading (gr-PM2.5/ft^3)	Inlet Temp (°F)	PM2.5 Control Efficiency
Baghouse Cloth/Paper Filter	0.5 – 10	<500	99% of filterable, 0% of condensable
Baghouse Ceramic Filter	0.5 – 10	<800	99% of filterable, 20% of condensable
Wet ESP	0.5 – 5	<200	98% of total
Dry ESP	0.5 – 5	<500	90% of filterable, 0% of condensable
Venturi/Wet Scrubber	0.1 – 50	<750	99% of total

As shown in the table above, the recommended inlet PM2.5 loading concentrations where these control technologies are applied are orders of magnitude above the typical exhaust PM2.5 concentrations produced by NG-fired boilers and steam generators. As the control device must be sized to accommodate the airflow, these devices must be substantially oversized for the quantity of PM they will control. All of these control technologies are able to provide good control efficiency of filterable PM. However, since the majority of total PM2.5 from NG boilers and steam generators is condensable PM2.5, baghouses with cloth/paper/ceramic filter media and dry ESPs are not well suited to control PM2.5 emissions from NG-fired boilers and steam generators because these emission control technologies have minimal to no ability to control condensable PM2.5 emissions.

Nonetheless, cost analyses for all of these control technologies listed in Table 2-2 above is presented in the following section.

Cost Effectiveness

Since the cost to deploy these technologies on a 50 MMBtu/hr boiler is similar to that of a 62.5 MMBtu/hr steam generator, a cost analysis is performed for each control technology for units at two heat input sizes: 20 MMBtu/hr and 62.5 MMBtu/hr. Purchased equipment costs were provided by equipment vendors.

[65] EPA-452/F-03-017 https://www3.epa.gov/ttnchie1/mkb/documents/fventuri.pdf#:~:text=EPA-452%2FF-03-017%20Air%20Pollution%20Control%20Technology%20Fact%20Sheet%20Name,venturi%20jet%20scrubbers%2C% 20gas-atomizing%20spray%20scrubbers%2C%20and%20ejector-venturiscrubbers

20 MMBtu/hr NG-Fired Boiler Controlled by a Fabric Filter Baghouse

	Item	Method of Calculation	Cost
	Direct Capital Costs		
A	Total Purchased Equip Cost	Western Pneumatics (7,300 acfm)	$100,000.00
B	Freight	5% Purchased Equip Cost (PEC)	$5,000.00
C	Sales Tax	8.25% PEC	$8,250.00
D	Direct Installation Costs	25% PEC	$25,000.00
E	Total Direct Capital Costs	A+B+C+D	$138,250.00
	Indirect Capital Costs		
F	Facilities	5% PEC	$5,000.00
G	Engineering	10% PEC	$10,000.00
H	Process Contingency	5% PEC	$5,000.00
I	Total Indirect Capital Costs	F+G+H	$20,000.00
J	Project Contingency	20% PEC	$20,000.00
K	Total Capital Costs	E+I+J	$178,250.00
L	**Annualized Capital Costs (10 Years @ 4%)**	0.123*K	$21,924.75
	Direct Annual Costs		
	Operating Costs		
M	Operator	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
N	Supervisor	15% of operator	$3,421.88
	Maintenance Costs		
O	Labor	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
P	Material	100% of Labor Cost	$13,687.50
	Utility Costs		
Q	Electricity Costs	0.1694/kw-hr EPA Cost Manual (452/B-02-001), Section 6, Chapter 1, Formula 1.14	$10,196.00
R	Total Direct Annual Costs	M+N+O+P+Q	$54,680.38
	Indirect Annual Costs		
S	Overhead	60% of O&M (M+N+O+P)	$26,690.63
T	Administrative	0.02 x PEC	$2,000.00
U	Insurance	0.01 x PEC	$1,000.00
V	Property Tax	0.01 x PEC	$1,000.00
W	Capital Recovery	0.13 x PEC	$13,000.00
X	Total Indirect Annual Costs	S+T+U+V+W	$43,690.63
Total Annualized Cost		L+R+X	**$120,295.76**

	Emission Reductions		
Y	Total PM10 Emissions (lb/year)	8760 hr/year x MMBtu/hrx 0.003	526
Z	Filterable PM10 (lb/year)	8760 hr/year x MMBtu/hr x 0.00075	131
AB	PM10 Captured by Baghouse (lb/year)	99% control of filterable	130
	PM10 Captured (tons/year)	AB/2000	**0.065**

Cost Effectiveness ($/ton)	**$1,850,704.00**

62.5 MMBtu/hr NG-Fired Boiler Controlled by a Fabric Filter Baghouse

	Item	Method of Calculation	Cost
	Direct Capital Costs		
A	Total Purchased Equip Cost	Western Pneumatics (17,400 acfm)	$180,000.00
B	Freight	5% Purchased Equip Cost (PEC)	$9,000.00
C	Sales Tax	8.25% PEC	$14,850.00
D	Direct Installation Costs	25% PEC	$45,000.00
E	Total Direct Capital Costs	A+B+C+D	$248,850.00
	Indirect Capital Costs		
F	Facilities	5% PEC	$9,000.00
G	Engineering	10% PEC	$18,000.00
H	Process Contingency	5% PEC	$9,000.00
I	Total Indirect Capital Costs	F+G+H	$36,000.00
J	Project Contingency	20% PEC	$36,000.00
K	Total Capital Costs	E+I+J	$320,850.00
L	**Annualized Capital Costs (10 Years @ 4%)**	0.123*K	$39,464.55
	Direct Annual Costs		
	Operating Costs		
M	Operator	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
N	Supervisor	15% of operator	$3,421.88
	Maintenance Costs		
O	Labor	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
P	Material	100% of Labor Cost	$13,687.50
	Utility Costs		
Q	Electricity Costs	0.1694/kw-hr EPA Cost Manual (452/B-02-001), Section 6, Chapter 1, Formula 1.14	$24,302.00
R	Total Direct Annual Costs	M+N+O+P+Q	$68,786.38
	Indirect Annual Costs		
S	Overhead	60% of O&M (M+N+O+P)	$26,690.63
T	Administrative	0.02 x PEC	$3,600.00
U	Insurance	0.01 x PEC	$1,800.00
V	Property Tax	0.01 x PEC	$1,800.00
W	Capital Recovery	0.13 x PEC	$23,400.00
X	Total Indirect Annual Costs	S+T+U+V+W	$57,290.63
Total Annualized Cost		L+R+X	**$165,541.56**

	Emission Reductions		
Y	Total PM10 Emissions (lb/year)	8760 hr/year x MMBtu/hrx 0.003	1,643
Z	Filterable PM10 (lb/year)	8760 hr/year x MMBtu/hr x 0.00075	411
AB	PM10 Captured by Baghouse (lb/year)	99% control of filterable	407
	PM10 Captured (tons/year)	AB/2000	**0.204**

Cost Effectiveness ($/ton)	**$811,478.24**

20 MMBtu/hr NG-Fired Boiler Controlled by a Ceramic Filter Baghouse

	Item	Method of Calculation	Cost
	Direct Capital Costs		
A	Total Purchased Equip Cost	Western Pneumatics (7,300 acfm)	$100,000.00
B	Freight	5% Purchased Equip Cost (PEC)	$5,000.00
C	Sales Tax	8.25% PEC	$8,250.00
D	Direct Installation Costs	25% PEC	$25,000.00
E	Total Direct Capital Costs	A+B+C+D	$138,250.00
	Indirect Capital Costs		
F	Facilities	5% PEC	$5,000.00
G	Engineering	10% PEC	$10,000.00
H	Process Contingency	5% PEC	$5,000.00
I	Total Indirect Capital Costs	F+G+H	$20,000.00
J	Project Contingency	20% PEC	$20,000.00
K	Total Capital Costs	E+I+J	$178,250.00
L	**Annualized Capital Costs (10 Years @ 4%)**	0.123*K	$21,924.75
	Direct Annual Costs		
	Operating Costs		
M	Operator	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
N	Supervisor	15% of operator	$3,421.88
	Maintenance Costs		
O	Labor	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
P	Material	100% of Labor Cost	$13,687.50
	Utility Costs		
Q	Electricity Costs	0.1694/kw-hr EPA Cost Manual (452/B-02-001), Section 6, Chapter 1, Formula 1.14	$10,196.00
R	Total Direct Annual Costs	M+N+O+P+Q	$54,680.38
	Indirect Annual Costs		
S	Overhead	60% of O&M (M+N+O+P)	$26,690.63
T	Administrative	0.02 x PEC	$2,000.00
U	Insurance	0.01 x PEC	$1,000.00
V	Property Tax	0.01 x PEC	$1,000.00
W	Capital Recovery	0.13 x PEC	$13,000.00
X	Total Indirect Annual Costs	S+T+U+V+W	$43,690.63
Total Annualized Cost		L+R+X	**$120,295.76**

	Emission Reductions		
Y	Total PM10 Emissions (lb/year)	8760 hr/year x MMBtu/hrx 0.003	526
Z	Filterable PM10 (lb/year)	8760 hr/year x MMBtu/hr x 0.00075	131
AA	Condensable PM10 (lb/year)	Y-Z	395
AB	PM10 Captured by Baghouse (lb/year)	0.99*Z+0.2*AA	209
	PM10 Captured (tons/year)	AB/2000	**0.105**

Cost Effectiveness ($/ton)	**$1,145,673.90**

62.5 MMBtu/hr NG-Fired Boiler Controlled by a Ceramic Filter Baghouse

	Item	Method of Calculation	Cost
	Direct Capital Costs		
A	Total Purchased Equip Cost	Western Pneumatics (17,400 acfm)	$180,000.00
B	Freight	5% Purchased Equip Cost (PEC)	$9,000.00
C	Sales Tax	8.25% PEC	$14,850.00
D	Direct Installation Costs	25% PEC	$45,000.00
E	Total Direct Capital Costs	A+B+C+D	$248,850.00
	Indirect Capital Costs		
F	Facilities	5% PEC	$9,000.00
G	Engineering	10% PEC	$18,000.00
H	Process Contingency	5% PEC	$9,000.00
I	Total Indirect Capital Costs	F+G+H	$36,000.00
J	Project Contingency	20% PEC	$36,000.00
K	Total Capital Costs	E+I+J	$320,850.00
L	**Annualized Capital Costs (10 Years @ 4%)**	0.123*K	$39,464.55
	Direct Annual Costs		
	Operating Costs		
M	Operator	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
N	Supervisor	15% of operator	$3,421.88
	Maintenance Costs		
O	Labor	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
P	Material	100% of Labor Cost	$13,687.50
	Utility Costs		
Q	Electricity Costs	0.1694/kw-hr EPA Cost Manual (452/B-02-001), Section 6, Chapter 1, Formula 1.14	$24,302.00
R	Total Direct Annual Costs	M+N+O+P+Q	$68,786.38
	Indirect Annual Costs		
S	Overhead	60% of O&M (M+N+O+P)	$26,690.63
T	Administrative	0.02 x PEC	$3,600.00
U	Insurance	0.01 x PEC	$1,800.00
V	Property Tax	0.01 x PEC	$1,800.00
W	Capital Recovery	0.13 x PEC	$23,400.00
X	Total Indirect Annual Costs	S+T+U+V+W	$57,290.63
Total Annualized Cost		L+R+X	**$165,541.56**

	Emission Reductions		
Y	Total PM10 Emissions (lb/year)	8760 hr/year x MMBtu/hrx 0.003	1,643
Z	Filterable PM10 (lb/year)	8760 hr/year x MMBtu/hr x 0.00075	411
AA	Condensable PM10 (lb/year)	Y-Z	1,232
AB	PM10 Captured by Baghouse (lb/year)	0.99*Z+0.2*AA	653
	PM10 Captured (tons/year)	AB/2000	**0.327**

Cost Effectiveness ($/ton)	**$506,243.30**

20 MMBtu/hr NG-Fired Boiler Controlled by a Wet ESP

	Item	Method of Calculation	Cost
	Direct Capital Costs		
A	Total Purchased Equip Cost	Envitech (7,000 acfm quencher & ESP)	$900,000.00
B	Freight	5% Purchased Equip Cost (PEC)	$45,000.00
C	Sales Tax	8.25% PEC	$74,250.00
D	Direct Installation Costs	25% PEC	$225,000.00
E	Total Direct Capital Costs	A+B+C+D	$1,244,250.00
	Indirect Capital Costs		
F	Facilities	5% PEC	$45,000.00
G	Engineering	10% PEC	$90,000.00
H	Process Contingency	5% PEC	$45,000.00
I	Total Indirect Capital Costs	F+G+H	$180,000.00
J	Project Contingency	20% PEC	$180,000.00
K	Total Capital Costs	E+I+J	$1,604,250.00
L	**Annualized Capital Costs (10 Years @ 4%)**	0.123*K	$197,322.75
	Direct Annual Costs		
	Operating Costs		
M	Operator	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
N	Supervisor	15% of operator	$3,421.88
	Maintenance Costs		
O	Labor	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
P	Material	100% of Labor Cost	$13,687.50
	Utility Costs		
Q	Electricity Costs	Envitech 25kW; 0.1694/kw-hr	$37,098.60
R	Total Direct Annual Costs	M+N+O+P+Q	$81,582.98
	Indirect Annual Costs		
S	Overhead	60% of O&M (M+N+O+P)	$26,690.63
T	Administrative	0.02 x PEC	$18,000.00
U	Insurance	0.01 x PEC	$9,000.00
V	Property Tax	0.01 x PEC	$9,000.00
W	Capital Recovery	0.13 x PEC	$117,000.00
X	Total Indirect Annual Costs	S+T+U+V+W	$179,690.63
Total Annualized Cost		L+R+X	**$458,596.36**

	Emission Reductions		
Y	Total PM10 Emissions (lb/year)	8760 hr/year x MMBtu/hrx 0.003	526
AB	PM10 Captured by ESP (lb/year)	98% control efficiency, Z*0.98	515
	PM10 Captured (tons/year)	AB/2000	**0.258**

Cost Effectiveness ($/ton)	**$1,777,505.27**

62.5 MMBtu/hr NG-Fired Boiler Controlled by a Wet ESP

	Item	Method of Calculation	Cost
	Direct Capital Costs		
A	Total Purchased Equip Cost	Envitech (17,000 acfm quencher & ESP)	$1,125,000.00
B	Freight	5% Purchased Equip Cost (PEC)	$56,250.00
C	Sales Tax	8.25% PEC	$92,812.50
D	Direct Installation Costs	25% PEC	$281,250.00
E	Total Direct Capital Costs	A+B+C+D	$1,555,312.50
	Indirect Capital Costs		
F	Facilities	5% PEC	$56,250.00
G	Engineering	10% PEC	$112,500.00
H	Process Contingency	5% PEC	$56,250.00
I	Total Indirect Capital Costs	F+G+H	$225,000.00
J	Project Contingency	20% PEC	$225,000.00
K	Total Capital Costs	E+I+J	$2,005,312.50
L	**Annualized Capital Costs (10 Years @ 4%)**	0.123*K	$246,653.44
	Direct Annual Costs		
	Operating Costs		
M	Operator	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
N	Supervisor	15% of operator	$3,421.88
	Maintenance Costs		
O	Labor	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
P	Material	100% of Labor Cost	$13,687.50
	Utility Costs		
Q	Electricity Costs	Envitech 50kW; 0.1694/kw-hr	$74,197.20
R	Total Direct Annual Costs	M+N+O+P+Q	$118,681.58
	Indirect Annual Costs		
S	Overhead	60% of O&M (M+N+O+P)	$26,690.63
T	Administrative	0.02 x PEC	$22,500.00
U	Insurance	0.01 x PEC	$11,250.00
V	Property Tax	0.01 x PEC	$11,250.00
W	Capital Recovery	0.13 x PEC	$146,250.00
X	Total Indirect Annual Costs	S+T+U+V+W	$217,940.63
Total Annualized Cost		L+R+X	**$583,275.65**

	Emission Reductions		
Y	Total PM10 Emissions (lb/year)	8760 hr/year x MMBtu/hrx 0.003	1,643
AB	PM10 Captured by ESP (lb/year)	98% control efficiency, Z*0.98	1,610
	PM10 Captured (tons/year)	AB/2000	**0.805**

Cost Effectiveness ($/ton)	**$724,566.02**

20 MMBtu/hr NG-Fired Boiler Controlled by a Dry ESP

	Item	Method of Calculation	Cost
	Direct Capital Costs		
A	Total Purchased Equip Cost	Envitech (7,000 acfm ESP)	$750,000.00
B	Freight	5% Purchased Equip Cost (PEC)	$37,500.00
C	Sales Tax	8.25% PEC	$61,875.00
D	Direct Installation Costs	25% PEC	$187,500.00
E	Total Direct Capital Costs	A+B+C+D	$1,036,875.00
	Indirect Capital Costs		
F	Facilities	5% PEC	$37,500.00
G	Engineering	10% PEC	$75,000.00
H	Process Contingency	5% PEC	$37,500.00
I	Total Indirect Capital Costs	F+G+H	$150,000.00
J	Project Contingency	20% PEC	$150,000.00
K	Total Capital Costs	E+I+J	$1,336,875.00
L	**Annualized Capital Costs (10 Years @ 4%)**	0.123*K	$164,435.63
	Direct Annual Costs		
	Operating Costs		
M	Operator	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
N	Supervisor	15% of operator	$3,421.88
	Maintenance Costs		
O	Labor	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
P	Material	100% of Labor Cost	$13,687.50
	Utility Costs		
Q	Electricity Costs	Envitech 25kW; 0.1694/kw-hr	$37,098.60
R	Total Direct Annual Costs	M+N+O+P+Q	$81,582.98
	Indirect Annual Costs		
S	Overhead	60% of O&M (M+N+O+P)	$26,690.63
T	Administrative	0.02 x PEC	$15,000.00
U	Insurance	0.01 x PEC	$7,500.00
V	Property Tax	0.01 x PEC	$7,500.00
W	Capital Recovery	0.13 x PEC	$97,500.00
X	Total Indirect Annual Costs	S+T+U+V+W	$154,190.63
Total Annualized Cost		L+R+X	**$400,209.24**

	Emission Reductions		
Y	Total PM10 Emissions (lb/year)	8760 hr/year x MMBtu/hrx 0.003	526
Z	Filterable PM10 (lb/year)	8760 hr/year x MMBtu/hr x 0.00075	131
AB	PM10 Captured by ESP (lb/year)	90% control of filterable	118
	PM10 Captured (tons/year)	AB/2000	**0.059**

Cost Effectiveness ($/ton)	**$6,783,207.46**

62.5 MMBtu/hr NG-Fired Boiler Controlled by a Dry ESP

	Item	Method of Calculation	Cost
	Direct Capital Costs		
A	Total Purchased Equip Cost	Envitech (17,000 acfm ESP)	$750,000.00
B	Freight	5% Purchased Equip Cost (PEC)	$37,500.00
C	Sales Tax	8.25% PEC	$61,875.00
D	Direct Installation Costs	25% PEC	$187,500.00
E	Total Direct Capital Costs	A+B+C+D	$1,036,875.00
	Indirect Capital Costs		
F	Facilities	5% PEC	$37,500.00
G	Engineering	10% PEC	$75,000.00
H	Process Contingency	5% PEC	$37,500.00
I	Total Indirect Capital Costs	F+G+H	$150,000.00
J	Project Contingency	20% PEC	$150,000.00
K	Total Capital Costs	E+I+J	$1,336,875.00
L	**Annualized Capital Costs (10 Years @ 4%)**	0.123*K	$164,435.63
	Direct Annual Costs		
	Operating Costs		
M	Operator	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
N	Supervisor	15% of operator	$3,421.88
	Maintenance Costs		
O	Labor	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
P	Material	100% of Labor Cost	$13,687.50
	Utility Costs		
Q	Electricity Costs	Envitech 50kW; 0.1694/kw-hr	$74,197.20
R	Total Direct Annual Costs	M+N+O+P+Q	$118,681.58
	Indirect Annual Costs		
S	Overhead	60% of O&M (M+N+O+P)	$26,690.63
T	Administrative	0.02 x PEC	$15,000.00
U	Insurance	0.01 x PEC	$7,500.00
V	Property Tax	0.01 x PEC	$7,500.00
W	Capital Recovery	0.13 x PEC	$97,500.00
X	Total Indirect Annual Costs	S+T+U+V+W	$154,190.63
Total Annualized Cost		L+R+X	**$437,307.84**

	Emission Reductions		
Y	Total PM10 Emissions (lb/year)	8760 hr/year x MMBtu/hrx 0.003	4,161
Z	Filterable PM10 (lb/year)	8760 hr/year x MMBtu/hr x 0.00075	411
AB	PM10 Captured by ESP (lb/year)	90% control of filterable	370
	PM10 Captured (tons/year)	AB/2000	**0.185**

Cost Effectiveness ($/ton)	**$2,363,826.16**

20 MMBtu/hr NG-Fired Boiler Controlled by a Venturi Scrubber

	Item	Method of Calculation	Cost
	Direct Capital Costs		
A	Total Purchased Equip Cost	EnviroCare Micromist (7,000 acfm)	$400,000.00
B	Freight	5% Purchased Equip Cost (PEC)	$20,000.00
C	Sales Tax	8.25% PEC	$33,000.00
D	Direct Installation Costs	25% PEC	$100,000.00
E	Total Direct Capital Costs	A+B+C+D	$553,000.00
	Indirect Capital Costs		
F	Facilities	5% PEC	$20,000.00
G	Engineering	10% PEC	$40,000.00
H	Process Contingency	5% PEC	$20,000.00
I	Total Indirect Capital Costs	F+G+H	$80,000.00
J	Project Contingency	20% PEC	$80,000.00
K	Total Capital Costs	E+I+J	$713,000.00
L	**Annualized Capital Costs (10 Years @ 4%)**	0.123*K	$87,699.00
	Direct Annual Costs		
	Operating Costs		
M	Operator	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
N	Supervisor	15% of operator	$3,421.88
	Maintenance Costs		
O	Labor	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
P	Material	100% of Labor Cost	$13,687.50
	Utility Costs		
Q	Electricity Costs	0.1694/kw-hr EPA Cost Manual (452/B-02-001), Section 6, Chapter 1, Formula 1.14	$45,124.00
R	Total Direct Annual Costs	M+N+O+P+Q	$89,608.38
	Indirect Annual Costs		
S	Overhead	60% of O&M (M+N+O+P)	$26,690.63
T	Administrative	0.02 x PEC	$8,000.00
U	Insurance	0.01 x PEC	$4,000.00
V	Property Tax	0.01 x PEC	$4,000.00
W	Capital Recovery	0.13 x PEC	$52,000.00
X	Total Indirect Annual Costs	S+T+U+V+W	$94,690.63
Total Annualized Cost		L+R+X	**$271,998.01**

	Emission Reductions		
Y	Total PM10 Emissions (lb/year)	8760 hr/year x MMBtu/hrx 0.003	526
AB	PM10 Captured by Baghouse (lb/year)	99% efficiency	521
	PM10 Captured (tons/year)	AB/2000	**0.261**

Cost Effectiveness ($/ton)	**$1,042,137.97**

62.5 MMBtu/hr NG-Fired Boiler Controlled by a Venturi Scrubber

	Item	Method of Calculation	Cost
	Direct Capital Costs		
A	Total Purchased Equip Cost	EnviroCare Micromist (20,000 acfm)	$520,000.00
B	Freight	5% Purchased Equip Cost (PEC)	$26,000.00
C	Sales Tax	8.25% PEC	$42,900.00
D	Direct Installation Costs	25% PEC	$130,000.00
E	Total Direct Capital Costs	A+B+C+D	$718,900.00
	Indirect Capital Costs		
F	Facilities	5% PEC	$26,000.00
G	Engineering	10% PEC	$52,000.00
H	Process Contingency	5% PEC	$26,000.00
I	Total Indirect Capital Costs	F+G+H	$104,000.00
J	Project Contingency	20% PEC	$104,000.00
K	Total Capital Costs	E+I+J	$926,900.00
L	**Annualized Capital Costs (10 Years @ 4%)**	0.123*K	$114,008.70
	Direct Annual Costs		
	Operating Costs		
M	Operator	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
N	Supervisor	15% of operator	$3,421.88
	Maintenance Costs		
O	Labor	0.5 hr/shift, $25/hr, 3 shifts/day	$13,687.50
P	Material	100% of Labor Cost	$13,687.50
	Utility Costs		
Q	Electricity Costs	0.1694/kw-hr EPA Cost Manual (452/B-02-001), Section 6, Chapter 1, Formula 1.14	$128,925.00
R	Total Direct Annual Costs	M+N+O+P+Q	$173,409.38
	Indirect Annual Costs		
S	Overhead	60% of O&M (M+N+O+P)	$26,690.63
T	Administrative	0.02 x PEC	$10,400.00
U	Insurance	0.01 x PEC	$5,200.00
V	Property Tax	0.01 x PEC	$5,200.00
W	Capital Recovery	0.13 x PEC	$67,600.00
X	Total Indirect Annual Costs	S+T+U+V+W	$115,090.63
Total Annualized Cost		L+R+X	**$402,508.71**

	Emission Reductions		
Y	Total PM10 Emissions (lb/year)	8760 hr/year x MMBtu/hrx 0.003	1,643
AB	PM10 Captured by Baghouse (lb/year)	99% efficiency	1,627
	PM10 Captured (tons/year)	AB/2000	**0.814**

Cost Effectiveness ($/ton)	**$494,482.44**

The cost effectiveness values above are based on assumed full time (8,760 hr/yr) operation at full capacity, which results in the largest possible PM2.5 emission reductions. In reality, boilers and steam generators typically do not operate 8,760 hr/yr. Reduction in operational hours would reduce PM2.5 emissions proportionally. Since the design capacity of these control devices must be suited to maximum flow, reductions in operational time would not reduce purchase and operational costs of the control device to the same extent. Therefore, the cost effectiveness values presented herein represent a lower limit, and the true cost of reductions are expected to be higher.

As discussed above, the typical exhaust PM2.5 concentration from NG-fired boilers and steam generators is significantly below the recommended range of inlet loading concentrations for all of the PM2.5 emission control technologies assessed. Further, with the exception of wet ESP and Venturi Scrubbers, these control technologies offer poor control of condensable PM2.5 and therefore poor control of total PM2.5 emissions from NG-fired boilers and steam generators.

Furthermore, this analysis shows that the cost of direct PM2.5 control on NG-fired boilers and steam generators with these technologies ranges between $494,482 and $6,783,207 per ton of PM2.5 emissions reduced. Therefore, use of these emission control technologies to control direct PM2.5 emissions from NG-fired boilers and steam generators is not cost effective.

Based on this review, the District did not identify additional emission reduction opportunities at this time. The District will continue to work with operators of boilers, steam generators, and process heaters to develop, demonstrate, and deploy new emission control technologies. As part of this continued effort, the District will evaluate any advancements in addressing the above feasibility issues.

Other Potential Opportunities

Solar Powered Oilfield Steam Generation

Emissions from oilfield steam generators that provide steam to reduce the viscosity of oil in thermally enhanced oil recovery operations have been significantly reduced through decades of increasingly stringent rule requirements. Instead of fuel oil, steam generators today are powered by natural gas or field gas which are significantly cleaner. To ensure that all potential emission reduction opportunities are evaluated, the District performed a comprehensive review of solar powered steam generators.

In the Valley, two small pilot projects were conducted to demonstrate the feasibility of solar powered steam generation technologies and found that such technologies were not feasible:

Berry Petroleum Company: This company installed a small pilot test facility designed to use solar energy to pre-heat feed water for the existing natural gas fired steam generators. The system consisted of mirrors in a glass greenhouse (supplied by Glasspoint Solar). The mirrors were designed to focus solar energy onto a pipe carrying water to heat the water. The heated water would then be sent to the input of the steam generators. The facility had a designed heat production of 300 kW. This project operated for a short time and was ultimately shut down based on the following shortcomings:

1) Significant heat loss: The heat losses to the water from the pipe runs from the solar installation to the actual steam generator locations were such that the water delivered to the steam generators was ambient or slightly warmer.
2) Excessively large footprint requirement: The footprint of the solar steam generators needed to provide the thermal output of one 85 MMBtu steam generator would be excessively large.
3) Inconsistent steam quality: The inability of the solar steam generators to consistently generate the quality of steam that is needed for injection that is currently supplied by the steam generators.
4) Unreliable power: The solar steam generators would still need to be supplemented by gas fired steam generators at night and during cloudy days.

Chevron: This company installed a pilot solar thermal steam plant near Coalinga, consisting of 7,600 mirrors that would direct solar energy towards a single solar collector tower (supplied by Brightsource Energy). The heat collected in the tower would turn water into steam. The installation had a footprint of 100 acres. This system discontinued operation in 2014. Although information from Chevron on their findings on the performance of this project is unavailable, based on news articles,[66] the system was excessively costly. A news article referencing the manufacturer's SEC filings stated the company realized a 40 million dollar loss on the project.

Aera Energy: Despite the above-described challenges, in 2019, Aera Energy in collaboration with GlassPoint Solar considered the installation of a large 770-acre solar steam generation system adjacent to an Aera Energy oil production operation in western Kern County. However, in April of 2020, GlassPoint cancelled the project due to a lack of funding. This system would have generated the steam equivalent to approximately 10 gas-fired steam generators. The solar steam generators would still need to be supplemented by gas-fired steam generators at night and during cloudy days.

Based on discussions with Aera Energy, the project heavily relied on solar tax credits, the generation and sale of low carbon fuel standard credits, and the reduction in costs of greenhouse gas allowances for Aera. According to Aera Energy, there is no economic benefit to implementing such technologies. In fact, without the LCFS credits, the cost of steam using this solar technology would be as much as three times the current cost.

The project also faced technical challenges, similar to the above pilot projects. Furthermore, the gas-fired steam generators that are required to supplement the system

[66] http://www.naturalgasintel.com/articles/103562-potential-for-solar-assisted-eor-in-california-oilfield-still-unfulfilled and https://gigaom.com/2011/10/12/brightsources-solar-steam-project-went-way-over-budget/

could face difficulty meeting current rule limits due to the need to ramp up and down. There has not been a successful large scale implementation of such technologies.

In summary, solar powered oilfield steam generators are not yet feasible and still face significant technical and economic challenges as outlined below:

- **Costs:** The use of solar steam generation rely on a complex set of funding sources to make the operations economically feasible, including the Federal 30% tax credit, the value of California low-carbon fuel standards credits that may be generated as a result of using solar steam generation to produce oil, and a reduction in the costs for the oil producer of AB32 cap-and-trade credits required for their operations in California. The value of the GHG credits generated varies based on the price of credits on the open market. As the value of the credits is not fixed, the economic viability of a project may change depending on the value of the credits prior to construction and during operation. Even with available credits, the costs continue to be a challenge.

- **Land Availability:** Adequate open land next to the steam injection wells is needed to house the solar collectors. Both the amount of land and the distance of the land to the injection point are important factors. It is estimated that to create the steam needed to replace one steam generator would require 60 acres of solar generation. Finding the required amount of land available next to oilfield operations may be difficult. The solar systems have to be close to the steam injection wells. Otherwise, additional solar capacity will need to be developed to account for the heat loss because of travel distance.

- **Variability of Solar Steam Generation Output:** Solar steam generation plants need sunny days to be able to collect enough energy to make steam. During cloudy days and also during the night, the solar equipment would not make enough steam. Oilfield operators will need to supplement the solar operation with natural gas fired steam generators for when the solar equipment is not producing enough steam. On partly cloudy days, the natural gas steam generators would need to cycle on and off depending on the cloud cover. This may cause operational difficulties as the gas fired steam generators are tuned to operate at constant load. A variable load could cause emissions variability and potentially have emissions higher than that allowed in permit limits and/or District prohibitory rules.

Evaluation Findings

Rules 4306 and 4320 currently provide for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meet or exceed BACM requirements.

2.8 RULE 4307 (BOILERS, STEAM GENERATORS, AND PROCESS HEATERS - 2.0 MMBTU/HR TO 5.0 MMBTU/HR)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	2.39	2.28	2.13	2.01	1.90	1.83	1.80
NOx	3.53	3.29	2.94	2.44	2.19	2.03	1.96
	Winter Average - Tons per day						
PM2.5	2.35	2.25	2.09	1.97	1.86	1.79	1.76
NOx	3.42	3.19	2.85	2.36	2.11	1.95	1.88

District Rule 4307 Description

The District adopted Rule 4307 on December 15, 2005, and subsequently amended the rule April 21, 2016. The purpose of Rule 4307 is to limit NOx and CO emissions from boilers, steam generators, and process heaters. The rule applies to any gaseous fuel or liquid fuel fired boiler, steam generator, and process heater with a rated heat input of 2.0 MMBtu/hr up to and including 5.0 MMBtu/hr. This source category includes a wide range of industries including but not limited to medical facilities, educational institutions, office buildings, prisons, military facilities, hotels and industrial facilities achieving emission limits as low as 9 ppmv NOx.

How does District Rule 4307 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Techniques Guidelines or New Source Performance Standards applicable to this source category.

A. Alternative Control Techniques (ACT)

- *Alternative Control Techniques Document – NOx Emissions from Process Heaters (EPA-453/R-93-034 1993/09)*

The District evaluated the requirements contained within the ACT for NOx Emissions from Process Heaters and found no requirements that were more stringent than those already in Rule 4307.

- *Alternative Control Techniques Document – NOx Emissions from Industrial/Commercial/Institutional Boilers (EPA-453/R-94-022 1994/03)*

The District evaluated the requirements contained within the ACT for NOx Emissions from Industrial/Commercial/Institutional Boilers and found no requirements that were more stringent than those already in Rule 4307.

- *Alternative Control Techniques Document – NOx Emissions from Utility Boilers (EPA-453/R-94-023 1994/03)*

The District evaluated the requirements contained within the ACT for NOx Emissions from Utility Boilers and found no requirements that were more stringent than those already in Rule 4307.

State Regulations

There are no state regulations that apply to this source category.

How does District Rule 4307 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4307 to comparable requirements in rules from the following California nonattainment areas:

- Bay Area AQMD Regulation 9, Rule 7 (Amended May 4, 2011)[67]
- Bay Area AQMD Regulation 9, Rule 10 (Amended November 3, 2021)[68]
- Sacramento Metropolitan AQMD Rule 411 (Amended August 23, 2007)[69]
- San Diego County APCD Rule 69.2.2 (Adopted September 9, 2021)[70]
- South Coast AQMD Rule 1146.1 (Amended December 7, 2018)[71]
- South Coast AQMD Rule 1150.3 (Adopted February 5, 2021)[72]

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[67] BAAQMD. *Regulation 9, Rule 7 (Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters)*. (Amended May 4, 2011). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-7-nitrogen-oxides-and-carbon-monoxide-from-industrial-institutional-and-commercial-boiler/documents/rg0907.pdf?la=en&rev=ab95f36c2dd146528f1cf3c10596bce3

[68] BAAQMD. *Regulation 9, Rule 10 (Nitrogen Oxides and Carbon Monoxide from Boilers, Steam Generators, and Process Heaters in Refineries)*. (Amended November 3, 2021). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/refinery-rules-definitions/rg0910_20211103-pdf.pdf?la=en&rev=6e3872940d924000b45ea05f05b5a309

[69] SMAQMD. *Rule 411 (NOx from Boilers, Process Heaters, and Steam Generators).* (Amended August 8, 2007). Retrieved from: https://www.airquality.org/ProgramCoordination/Documents/rule411.pdf

[70] SCAQMD. *Rule 69.2.2 (Medium Boilers, Process Heaters, and Steam Generators).* (Adopted September 9, 2021). Retrieved from: https://www.sdapcd.org/content/dam/sdapcd/documents/rules/current-rules/Rule-69.2.2.pdf

[71] SCAQMD. *Rule 1146.1 (Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters).* (Amended December 7, 2018). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1146-1.pdf

[72] SCAQMD. *Rule 1150.3 (Emissions of Oxides of Nitrogen from Combustion Equipment at Landfills).* (Amended February 5, 2021). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1150-3.pdf?sfvrsn=10

- Ventura County APCD Rule 74.15.1 (Amended June 23, 2015)[73]

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4307 continues to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rules is demonstrated below.

Bay Area AQMD

- BAAQMD Regulation 9, Rule 10 (Boilers, Steam Generators and Process Heaters in Refineries)

BAAQMD amended Regulation 9, Rule 10 on November 3, 2021. The 2021 amendments were administrative and did not affect the stringency of rule requirements implemented prior to EPA's approval of the District meeting BACM/MSM for the *2018 PM2.5 Plan*. The District found no requirements in BAAQMD Regulation 9, Rule 10 that were more stringent than those in Rule 4307.

San Diego County APCD

- SDAPCD Rule 69.2.2 (Medium Boilers, Process Heaters, and Steam Generators)

	SJVAPCD Rule 4307	SDAPCD Rule 69.2.2
Applicability	Gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2 MMBtu/hr to ≤5 MMBtu/hr.	Boilers, steam generator and process heaters >2 MMBtu/hr to <5 MMBtu/hr.
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where products of combustion come in direct contact with material to be heated • Unfired or fired waste heat recovery boilers used to recover or augment heat from exhaust of combustion turbines or internal combustion engines • Burning other fuel during PUC quality natural gas curtailment as long as other fuel not be burned for more than 168 hr/yr plus 48 hr/yr for equipment testing, and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• Waste heat recovery boilers • Furnaces, kilns, and any combustion equipment where the material being heated is in direct contact with the products of combustion • Thermal oxidizers and associated waste heat recovery equipment • Units which burn liquid fuel only during periods of natural gas curtailment, emergencies, or equipment testing for the purpose of maintaining the fuel oil back-up system

[73] VCAPCD. *Rule 14.15.1 (Boilers, Steam Generators, and Process Heaters).* (Amended June 23, 2015). Retrieved from: http://www.vcapcd.org/Rulebook/Reg4/RULE%2074.15.1.pdf

	SJVAPCD Rule 4307	SDAPCD Rule 69.2.2
Requirements	***NOx Emission Limits:** New and Replacement units • 12 ppmv (atmospheric units) • 9 ppmv (non-atmospheric units) Existing units limited to 1.8 billion Btu/yr • Install and maintain non-resettable fuel flow meter; AND • Tune-up the unit twice per calendar year, OR • Operate and maintain the stack O2 concentrations at 3% by vol. or less on a dry basis, OR • Certify unit to comply with 30 ppmv NOx and 400 ppmv CO (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units Existing atmospheric units in oilfield or refinery; each glycol reboiler; or each unit with heat input >1.8 to <5 billion Btu/yr • 30 ppmv (gaseous fuel) • 40 ppmv (liquid fuel)	***NOx Emission Limits:** Existing or relocated units • Tune the unit once per year (no two tuning events shall occur within 90 days of each other) New Units (effective July 1, 2021) • 30 ppmv (gaseous fuel) • 40 ppmv (liquid fuel) • 400 ppmv CO
	PM Control Requirements: • Use PUC quality natural gas, propane, butane, LPG or a combination of such gases, OR • Limit fuel sulfur content to no more than 5 grains/100 scf of gas; OR • Install and operate control system that reduces SO2 emissions at least 95% by wt., or limit exhaust SO2 concentration to ≤9 ppmv @ 3% O2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppmv sulfur	**PM Control Requirements:** None

*Unless otherwise stated, all ppmv values are on a dry basis and corrected to 3% stack oxygen by volume.

District Rule 4307 contains NOx limits for existing units, while SDAPCD Rule 69.2.2 does not, and District Rule 4307 contains more stringent NOx limits for new units. Therefore, District Rule 4307 is as stringent as or more stringent than SDAPCD Rule 69.2.2.

South Coast AQMD

- SCAQMD Rule 1146.1 (Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters)

	SJVAPCD Rule 4307	SCAQMD Rule 1146.1
Applicability	Gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2 MMBtu/hr to ≤5 MMBtu/hr.	Boilers, steam generator and process heaters >2 MMBtu/hr to <5 MMBtu/hr.
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where products of combustion come in direct contact with material to be heated • Unfired or fired waste heat recovery boilers used to recover or augment heat from exhaust of combustion turbines or internal combustion engines • Burning other fuel during PUC quality natural gas curtailment as long as other fuel not be burned for more than 168 hr/yr plus 48 hr/yr for equipment testing, and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• Units at a RECLAIM or former RECLAIM facility subject to a NOx limit in a different rule • Units at municipal sanitation service facility subject to a NOx emission limit in Reg XI adopted or amended after 12/7/18
Requirements	***NOx Emission Limits:** <u>New and Replacement units</u> • 12 ppmv (atmospheric units) • 9 ppmv (non-atmospheric units) <u>Existing units limited to 1.8 billion Btu/yr</u> • Install and maintain non-resettable fuel flow meter; AND • Tune-up the unit twice per calendar year, OR • Operate and maintain the stack O2 concentrations at 3% by vol. or less on a dry basis, OR • Certify unit to comply with 30 ppmv NOx and 400 ppmv CO (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units <u>Existing atmospheric units in oilfield or refinery; each glycol reboiler; or each unit with heat input >1.8 to <5 billion Btu/yr</u> • 30 ppmv (gaseous fuel) • 40 ppmv (liquid fuel)	***NOx Emission Limits:** <u>Existing units (in operation prior to 9/5/08, at non-RECLAIM facilities, or in operation prior to 12/7/19 at RECLAIM or former RECLAIM) limited to ≤1.8 billion Btu/yr</u> • Operate and maintain stack O2 concentrations at 3% by vol. or less for any 15-consecutive-minute averaging period, OR • Tune-in the unit twice per year (4 to 8 months apart) <u>All Other Units</u> • 30 ppmv for natural gas-fired units not mentioned below: • 7 ppmv for any fire-tube boilers on natural gas** • 9 ppmv for natural gas fired units excluding fire-tube boilers, atmospheric units, and thermal fluid heaters*** • 12 ppmv for natural gas-fired atmospheric units • 12 ppmv for natural gas-fired thermal fluid heaters**** • 15 ppmv for digester gas fired units • 25 ppmv for landfill gas fired units • Weight average limit for multi-fuel units (e.g., units using both natural gas and digester gas, etc.)

	SJVAPCD Rule 4307	SCAQMD Rule 1146.1
		***Units with ≤12 ppmv NOx, >9 ppmv NOx, and ≤9 ppmv NOx installed, modified, or issued permits prior to 12/7/18, at a non-RECLAIM facility will become subject to the 7 ppmv NOx limit when 50% or more of unit's burners are replaced, or by 12/7/33, whichever is earlier.* ****Units with ≤12 ppmv NOx and >9 ppmv NOx installed, modified or issued permits prior to 9/5/08, at a non-RECLAIM facility will become subject to the 9 ppmv NOx limit when 50% or more of unit's burners are replaced, or by 12/7/33, whichever is earlier.* *****Units with ≤30 ppmv NOx installed, modified, or issued permits prior to 12/7/18, at a non-RECLAIM facility will become subject to the 12 ppmv NOx limit when 50% or more of unit's burners are replaced, or by 12/7/33, whichever is earlier.*
	PM Control Requirements: • Use PUC quality natural gas, propane, butane, LPG or a combination of such gases, OR • Limit fuel sulfur content to no more than 5 grains/100 scf of gas; OR • Install and operate control system that reduces SO2 emissions at least 95% by wt., or limit exhaust SO2 concentration to ≤9 ppmv @ 3% O2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppmv sulfur	**PM Control Requirements:** None

*Unless otherwise stated, all ppmv values are on a dry basis and corrected to 3% stack oxygen by volume.

SCAQMD Rule 1146.1 regulates NOx and CO emissions from small industrial, institutional, and commercial boilers, steam generators, and process heaters. The District compared the emission limits in District Rule 4307 with SCAQMD Rule 1146.1 and concluded that NOx requirements in the District rule are at least equivalent or more stringent than the SCAQMD rule limits for similarly rated units. Therefore, District Rule 4307 is as stringent as or more stringent than SCAQMD Rule 1146.1.

- SCAQMD Rule 1150.3 (Emissions of Oxides of Nitrogen From Combustion Equipment at Landfills)

This rule includes limits for units operating at landfills. The District does not currently have any applicable boilers, steam generators, or process heaters operating at landfills.

Ventura County APCD

- VCAPCD Rule 74.15.1 (Boilers, Steam Generators, and Process Heaters)

	SJVAPCD Rule 4307	VCAPCD Rule 74.15.1
Applicability	Gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2 MMBtu/hr to ≤5 MMBtu/hr.	Gaseous fuel or liquid fuel fired boilers, steam generators, or process heaters rated ≥1 MMBtu/hr and <5 MMBtu/hr.

Exemptions	• Solid fuel fired units
	• Dryers and glass melting furnaces
	• Kilns, humidifiers, and smelters where products of combustion come in direct contact with material to be heated
	• Unfired or fired waste heat recovery boilers used to recover or augment heat from exhaust of combustion turbines or internal combustion engines
	• Burning other fuel during PUC quality natural gas curtailment as long as other fuel not be burned for more than 168 hr/yr plus 48 hr/yr for equipment testing, and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu
		• Any unit operated on alternate fuel under following conditions:
		  ○ Alternate fuel use required due to natural gas curtailment period.
		  ○ Alternative fuel use is required to maintain the alternate fuel system, and in this case use shall not exceed 50 hr/yr
		• Portable oil well dewaxing process heater is not subject to 30 ppmv NOx, if annual heat input rate is <2.8 billion Btu

Requirements	***NOx Emission Limits:** <u>New and Replacement units</u> • 12 ppmv (atmospheric units) • 9 ppmv (non-atmospheric units) <u>Existing units limited to 1.8 billion Btu/yr</u> • Install and maintain non-resettable fuel flow meter; AND • Tune-up the unit twice per calendar year, OR • Operate and maintain the stack O2 concentrations at 3% by vol. or less on a dry basis, OR • Certify unit to comply with 30 ppmv NOx and 400 ppmv CO (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units <u>Existing atmospheric units in oilfield or refinery; each glycol reboiler; or each unit with heat input >1.8 to <5 billion Btu/yr</u> • 30 ppmv (gaseous fuel) • 40 ppmv (liquid fuel)	***NOx Emission Limits:** <u>Units with heat input rate ≥1.8 billion Btu/yr</u> • 30 ppmv <u>New and Replacement Units ≥1 to ≤2 MMBtu/hr</u> • 20 ppmv (natural gas-fired) <u>New and Replacement Units >2 to <5 MMBtu/hr</u> • 12 ppmv (natural gas, atmospheric) • 9 ppmv (natural gas, pressurized) • 25 ppmv (landfill gas) • 15 ppmv (biogas) • 20 ppmv (LPG) • 15 ppmv (produced oilfield gas, atmospheric) • 12 ppmv (produced oilfield gas, pressurized) <u>Units ≥0.3 billion Btu/yr and <1.8 billion Btu/yr</u> Comply with one of the following: • Units shall be tuned every 6 months or after 750 hours of operation, but in no case less than once per calendar year; OR • The unit shall comply with the emission and testing requirements (20-30 ppmv NOx)

	SJVAPCD Rule 4307	VCAPCD Rule 74.15.1
	PM Control Requirements: • Use PUC quality natural gas, propane, butane, LPG or a combination of such gases, OR • Limit fuel sulfur content to no more than 5 grains/100 scf of gas; OR • Install and operate control system that reduces SO2 emissions at least 95% by wt., or limit exhaust SO2 concentration to ≤9 ppmv @ 3% O2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppmv sulfur	**PM Control Requirements:** None

*Unless otherwise stated, all ppmv values are on a dry basis and corrected to 3% stack oxygen by volume.

VCAPCD Rule 74.15.1 regulates NOx and CO emissions from boilers, steam generators, and process heaters. The District compared the emission limits in District Rule 4307 with VCAPCD and concluded that Rule 4307 is overall as stringent as VCAPCD Rule 74.15.1.

Potential Emission Reduction Opportunities

Beyond the review of current regulations and rule requirements, the District reviewed the feasibility of technologies and measures implemented in other regions and potential new technologies and measures that may be feasible for implementation in the near future.

NOx Emission Control Technologies

Most units subject to Rule 4307 are fired on Public Utilities Commission (PUC) quality natural gas, and are able to install established control technologies. The following potential control techniques are evaluated to achieve further reductions:

Retrofitting with SCR

SCR technology is predominantly used to reduce NOx emissions from boilers, steam generators, and process heaters. While many of existing units already use SCR to control NOx emissions, enhanced SCR systems may be required to further reduce emissions. As confirmed by a local vendor, the cost of SCR systems to further reduce emissions including the SCR housing, catalyst, ammonia injection system, and ammonia flow control system could cost approximately $220,000. This information is used as a basis to estimate the annualized cost for this control technique.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE):			
SCR system	A	220,000	Boiler vendor
Instrumentation and controls	0.01 A	--	Included above

Description of Cost	Cost Factor	Cost	Source
Sales taxes	0.08 A	17,600	
Freight	0.05 A	11,000	OAQPS
Purchased equipment cost, PEC	B = 1.14 A	248,600	
Direct installation costs (DI):			
Foundation & supports	0.08 B	19,888	OAQPS
Handling and erection	0.14 B	34,804	OAQPS
Electrical	0.04 B	9,944	OAQPS
Piping	0.02 B	4,972	OAQPS
Insulation and ductwork:	0.01 B	2,486	OAQPS
Painting	0.01 B	2,486	OAQPS
Direct installation costs	0.30 B	74,580	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC	1.30B + SP + Bldg.	323,180	
Indirect Costs (Installation)			
Engineering	0.10 B	24,860	OAQPS
Construction and field expenses	0.05 B	12,430	OAQPS
Contractor fees	0.10 B	24,860	OAQPS
Contingencies	0.03 B	7,458	OAQPS
Start-up	0.02 B	4,972	OAQPS
Performance test	0.01 B	2,486	OAQPS
Total indirect costs, IC	0.31 B	77,066	
Total Capital Investments (TCI = DC + IC):	**1.61 B + SP + Bldg.**	400,246	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**65,120**	
Direct Annual Costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance costs (labor and material)	0.015 TCI	6,004	OAQPS
Reagent costs (anhydrous ammonia)		--	Not estimated
Electricity cost	$0.08848/kWH	--	Not estimated
Catalyst replacement	--	--	Catalyst presumed to last at least over 10 years
Total DAC:		6,004	
Indirect Annual Costs (IAC)			
Overhead	--	--	See table footnote
Insurance	0.01 TCI	4,002	OAQPS
Property tax	--	--	See table footnote
Administrative	--	--	See table footnote
Total IAC:		4,002	
Total Annual Cost (DAC + IAC)		10,006	
Total annual cost (Annualized TCI + Total annual cost)		**75,126**	

*Per EPA's Air Pollution Control Cost Manual (6th Edition), EPA/452/B-02-001 (1/02), operating and supervisory, overhead, administrative costs would be insignificant for an SCR system. In general, SCR does not require site preparation or additional buildings, and property taxes do not apply to capital improvements such as air pollution control equipment.

The potential NOx emission reduction for each category is determined by taking the difference between the potential emissions and the emissions that could be reliably achievable by an SCR system. SCR is expected to reliably achieve 5 ppmv NOx @ 3%

O2. The total cost for each category is determined by multiplying the number of units and $75,126 for a typical annual cost of an SCR system.

Type of unit	Number of units	Potential NOx Reductions with SCR Technology (tons/yr)	Total annualized cost of NOx Reductions with SCR Technology ($/yr)	Cost effectiveness ($/ton of emission reduction)
New and replacement units, 12 ppmv NOx	36 (35*+1**)	5.0 (4.9*+0.1**)	2,704,536	**$540,907/ton**
New and replacement units, 9 ppmv NOx	209 (192*+17**)	17.2 (15.8*+1.4**)	15,701,334	**$912,868/ton**
Existing units – gaseous fuel, 30 ppmv NOx	260 (244*+16**)	138.8 (132.4*+6.4**)	19,532,760	**$140,726/ton**
Existing units – gaseous fuel, low-use, ≤1.8 billion Btu/yr	102*	8.8*	7,662,852	**$870,779/ton**
Existing units – gaseous fuel, ≤5 billion Btu/yr	1*	--	--	--
Existing units – liquid fuel, ≤5 billion Btu/yr	1*	--	--	--
Existing units – gaseous fuel with diesel backup, 15 ppmv NOx	3**	0.8**	225,378	**$281,723/ton**
Existing units – gaseous fuel with diesel backup, 20 ppmv NOx	7**	2.7**	525,882	**$194,771/ton**
Miscellaneous – existing units with gaseous or liquid fuels	9**,***	--	--	--

*Active PEERs, **Active PTOs, ***4 units out of 9 units are dormant

Retrofitting with Ultra Low-NOx Burner

A boiler, steam generator, or process heater can be retrofitted with an ultra-low NOx burner (ULNB) to reliably achieve 9 ppmv NOx @ 3% O2. As provided by a local vendor, the cost of a ULNB would be about $70,000. However, retrofitting an existing boiler may not always be feasible and if feasible, it may involve upgrades to various systems such as fuel trains to comply with current codes, and upgrades to air intake fans, as these units require more air for the burner to operate at its optimum level. These additional items are not included in the calculations below, but can add considerable costs to the retrofit.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE):			
Burner system (replacement burner, controls, and fuel train systems)	A	77,000	Local vendor
Instrumentation and controls	0.01 A	--	Included above
Sales taxes	0.08 A	6,160	
Freight	0.05 A	3,850	OAQPS
Purchased equipment cost, PEC		87,010	
Direct installation costs (DI):			
Foundation & supports	0.08 B	--	See footnote

Description of Cost	Cost Factor	Cost	Source
Handling and erection	0.14 B	12,181	OAQPS
Electrical	0.04 B	3,480	OAQPS
Piping	0.02 B	1,740	OAQPS
Insulation and ductwork:	0.01 B	870	OAQPS
Painting	0.01 B	870	OAQPS
Direct installation costs		19,141	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC		106,151	
Indirect Costs (Installation)			
Engineering	0.10 B	8,701	OAQPS
Construction and field expenses	0.05 B	4,351	OAQPS
Contractor fees	0.10 B	8,701	OAQPS
Contingencies	0.03 B	2,610	OAQPS
Start-up	0.02 B	1,740	OAQPS
Performance test	0.01 B	870	OAQPS
Total indirect costs, IC	0.31 B	26,973	
Total Capital Investments (TCI = DC + IC):		133,125	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**21,659**	
Direct annual costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance costs (labor and material)	--	--	
Electricity cost	$0.08848/kWH	--	Not estimated
Indirect Annual Costs (IAC)			
Overhead	--	--	See table footnote
Insurance	--	--	See table footnote
Property tax	--	--	See table footnote
Administrative	--	--	See table footnote
Total Annual Cost (DAC + IAC)		--	
Total annual cost (annualized TCI + Total annual cost)		**21,659**	

*The existing foundation and supports will not be replaced; direct annual cost and indirect annual costs are presumed to be same as the existing burner

The potential NOx emission reduction for each category is determined by taking the difference between the potential emissions and the emissions that could be reliably achievable by a ULNB system. A ULNB is expected to reliably achieve 9 ppmv NOx @ 3% O2. Each unit is presumed to be operated for 8,760 hours per year at the maximum rated capacity. The total cost for each category is determined by multiplying the number of units and $21,659, a typical annual cost of a ULNB system.

Type of unit	Number of units	Potential NOx Reductions with ULNB Technology (tons/yr)	Total annualized cost of NOx Reductions with burner retrofit ($/yr)	Cost effectiveness ($/ton of emission reduction)
New and replacement units, 12 ppmv NOx	36 (35*+1**)	2.1 (2.1*+0.0*)	779,724	**$371,297/ton**
New and replacement units, 9 ppmv NOx	209 (192*+17**)	Not needed, units are already equipped with 9 ppmv burner		

Existing units – gaseous fuel, 30 ppmv NOx	260 (244*+16**)	116.6 (111.2*+5.4**)	5,631,340	**$48,296/ton**
Existing units – gaseous fuel, low-use, ≤1.8 billion Btu/yr	102*	8.3*	2,209,218	**$266,171/ton**
Existing units – gaseous fuel, ≤5 billion Btu/yr	1*	--	--	--
Existing units – liquid fuel, ≤5 billion Btu/yr	1*	--	--	--
Existing units – gaseous fuel with diesel backup, 15 ppmv NOx	3**	0.5**	64,977	**$129,954/ton**
Existing units – gaseous fuel with diesel backup, 20 ppmv NOx	7**	2.0**	151,613	**$75,807/ton**
Miscellaneous – existing units with gaseous or liquid fuels	9**,***	--	--	--

*Active PEERs, **Active PTOs, ***4 units out of 9 units are dormant

Replacing Older Unit with New Unit (Achieving 9 ppmv NOx)

Replacement of an older boiler in many cases may be the only way to reduce NOx emissions. New units can reliably achieve 9 ppmv NOx @ 3% O2. The cost of these units depends on the heat input rate, use of unit (steam, hot water, etc.), control system, and heat recovery systems (economizer etc.). Per a local vendor, the cost of a steam boiler rated at 5.0 MMBtu/hr (300 psi) would be $165,000. The majority (>90%) of the units are greater than 2.0 MMBtu/hr; therefore, it is reasonable to use this cost data for the cost effectiveness analysis.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE):			
Replacing an older unit	A	165,000	Local vendor
Instrumentation and controls	0.01 A	1,650	OAQPS
Sales taxes	0.08 A	13,200	
Freight	0.05 A	8,250	OAQPS
Purchased equipment cost, PEC		188,100	
Direct installation costs (DI):			
Foundation & supports	0.08 B	15,048	See footnote
Handling and erection	0.14 B	26,334	OAQPS
Electrical	0.04 B	7,524	OAQPS
Piping	0.02 B	3,762	OAQPS
Insulation and ductwork:	0.01 B	1,881	OAQPS
Painting	0.01 B	1,881	OAQPS
Direct installation costs		56,430	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC		244,530	
Indirect Costs (Installation)			
Engineering	0.10 B	18,810	OAQPS
Construction and field expenses	0.05 B	9,405	OAQPS
Contractor fees	0.10 B	18,810	OAQPS

Description of Cost	Cost Factor	Cost	Source
Contingencies	0.03 B	5,643	OAQPS
Start-up	0.02 B	3,762	OAQPS
Performance test	0.01 B	1,881	OAQPS
Total indirect costs, IC	0.31 B	58,311	
Total Capital Investments (TCI = DC + IC):		302,841	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**49,272**	
Direct annual costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance costs (labor and material)	--	--	
Electricity cost	$0.08848/kWH	--	Not estimated
Indirect Annual Costs (IAC)			
Overhead	--	--	See table footnote
Insurance	--	--	See table footnote
Property tax	--	--	See table footnote
Administrative	--	--	See table footnote
Total Annual Cost (DAC + IAC)		--	
Total annual cost (Annualized TCI + Total annual cost)		**49,272**	

*Direct annual cost and indirect annual costs are presumed to be same as the existing unit

The potential NOx emission reduction for each category is determined by taking the difference between the potential emissions and the emissions that could be reliably achievable by the use of a new unit equipped with a ULNB system. A ULNB is expected to reliably achieve 9 ppmv NOx @ 3% O2. Each unit is presumed to be operated for 8,760 hours per year at the maximum rated capacity. The total cost for each category is determined by multiplying the number of units and $49,272, a typical annual cost of a unit with a ULNB system.

Type of unit	Number of units	Potential NOx reductions w/ new unit equipped w/ ULNB Technology (tons/yr)	Total annualized cost of NOx reductions w/ new unit equipped w/ ULNB Technology ($/yr)	Cost effectiveness ($/ton of emission reduction)
New and replacement units, 12 ppmv NOx	36 (35*+1**)	2.1 (2.1*+0.0*)	1,773,792	**$844,663/ton**
New and replacement units, 9 ppmv NOx	209 (192*+17**)	Not needed, units equipped with 9 ppmv burner		
Existing units – gaseous fuel, 30 ppmv NOx	260 (244*+16**)	116.6 (111.2*+5.4**)	12,810,720	**$109,869/ton**
Existing units – gaseous fuel, low-use, ≤1.8 billion Btu/yr	102*	8.3*	5,025,744	**$605,511/ton**
Existing units – gaseous fuel, ≤5 billion Btu/yr	1*	--	--	--
Existing units – liquid fuel, ≤5 billion Btu/yr	1*	--	--	--

Existing units – gaseous fuel with diesel backup, 15 ppmv NOx	3**	0.5**	147,816	**$295,632/ton**
Existing units – gaseous fuel with diesel backup, 20 ppmv NOx	7**	2.0**	344,904	**$172,452/ton**
Miscellaneous – existing units with gaseous or liquid fuels	9**,***	--	--	--

*Active PEERs, **Active PTOs, ***4 units out of 9 units are dormant

Replacing Older Unit with New Unit and SCR System (Achieving 5 ppmv NOx)

The District confirmed with a boiler vendor that a boiler between 2.0-5.0 MMBtu/hr cannot achieve 5 ppmv NOx @ 3% O2 with the use of a ULNB alone. A new boiler must be equipped with an SCR system to reliably achieve 5 ppmv NOx for this heat input range. The capital cost of a new boiler with an SCR system is estimated to be at least $385,000.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE):			
New steam-boiler + SCR system to achieve 5 ppm	A	385,000	Local Vendor
Instrumentation and controls	0.01 A	3,850	OAQPS
Sales Taxes	0.08 A	30,800	
Freight	0.05 A	19,250	OAQPS
Purchased equipment cost, PEC		438,900	
Direct installation costs (DI):			
Foundation & supports	0.08 B	35,112	See footnote
Handling and erection	0.14 B	61,446	OAQPS
Electrical	0.04 B	17,556	OAQPS
Piping	0.02 B	8,778	OAQPS
Insulation and ductwork:	0.01 B	4,389	OAQPS
Painting	0.01 B	4,389	OAQPS
Direct installation costs		131,670	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC		570,570	
Indirect Costs (Installation)			
Engineering	0.10 B	43,890	OAQPS
Construction and field expenses	0.05 B	21,945	OAQPS
Contractor fees	0.10 B	43,890	OAQPS
Contingencies	0.03 B	13,167	OAQPS
Start-up	0.02 B	8,778	OAQPS
Performance test	0.01 B	4,389	OAQPS
Total Indirect Costs, IC	0.31 B	136,059	
Total Capital Investments (TCI = DC + IC):		706,629	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**114,969**	

Description of Cost	Cost Factor	Cost	Source
Direct Annual Costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance costs (labor and material)	--	--	
Electricity cost	$0.08848/kWH	--	Not estimated
Indirect Annual Costs (IAC)			
Overhead	--	--	See table footnote
Insurance	--	--	See table footnote
Property Tax	--	--	See table footnote
Administrative	--	--	See table footnote
Total Annual Cost (DAC + IAC)		--	
Total annual cost (Annualized TCI + Total annual cost)		**114,969**	

*Direct annual cost and indirect annual costs are presumed to be same as the existing unit

The potential NOx emission reduction for each category is determined by taking the difference between the potential emissions and the emissions that could be reliably achievable by the use of a new unit equipped with an SCR system. A unit with an SCR is expected to reliably achieve 5 ppmv NOx @ 3% O2. Each unit is presumed to be operated for 8,760 hours per year at the maximum rated capacity. The total cost for each category is determined by multiplying the number of units and $114,969, a typical annual cost of a unit with an SCR system.

Type of unit	Number of units	Potential NOx reductions w/ new unit equipped w/SCR Technology (tons/yr)	Total annualized cost of NOx reductions w/ new unit equipped w/ SCR Technology ($/yr)	Cost effectiveness ($/ton of emission reduction)
New and replacement units, 12 ppmv NOx	36 (35*+1**)	5.0 (4.9*+0.1**)	4,138,884	**$827,777/ton**
New and replacement units, 9 ppmv NOx	209 (192*+17**)	17.2 (15.8*+1.4**)	24,028,521	**$1,397,007/ton**
Existing units – gaseous fuel, 30 ppmv NOx	260 (244*+16**)	138.8 (132.4*+6.4**)	29,891,940	**$215,360/ton**
Existing units – gaseous fuel, low-use, ≤1.8 billion Btu/yr	102*	8.8*	11,726,838	**$1,332,595/ton**
Existing units – gaseous fuel, ≤5 billion Btu/yr	1*	--	--	--
Existing units – liquid fuel, ≤5 billion Btu/yr	1*	--	--	--
Existing units – gaseous fuel with diesel backup, 15 ppmv NOx	3**	0.8**	344,907	**$431,134/ton**
Existing units – gaseous fuel with diesel backup, 20 ppmv NOx	7**	2.7**	804,783	**$298,068/ton**
Miscellaneous – existing units with gaseous or liquid fuels	9**,***	--	--	--

*Active PEERs, **Active PTOs, ***4 units out of 9 units are dormant

Use of EMx System

The District researched post-combustion controls such as EMx, the second generation of the SCONOx technology that reduces NOx, SOx, CO, and VOC emissions. Per EmeraChem, manufacturer/vendor of the technology, this technology has not been achieved in practice for natural gas fired boilers. SCONOx and EMx systems have only been used by power plants for the control of turbine emissions. The cost of an EMx system would be anywhere from $3 to $5 million, or even up to $8 million in some cases for large power plant installations. Moreover, an EMx system is ideal for a new installation, but becomes extremely challenging and sometimes nearly impossible to retrofit to an existing unit. In fact, cost effectiveness analyses conducted by the District for the installation of SCONOx/EMx units on large power plant turbine installations within the Valley have shown that this technology is not cost effective. Given the high cost effectiveness demonstrated for turbines and lack of demonstrated practice with boilers, this technology is not feasible or cost effective for reducing emissions from this category.

Based on this analysis, the District did not identify additional emission reduction opportunities at this time.

Evaluation Findings

Rule 4307 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.9 RULE 4308 (BOILERS, STEAM GENERATORS, AND PROCESS HEATERS - 0.075 MMBTU/HR TO LESS THAN 2.0 MMBTU/HR)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	2.39	2.28	2.13	2.01	1.90	1.83	1.80
NOx	3.53	3.29	2.94	2.44	2.19	2.03	1.96
	Winter Average - Tons per day						
PM2.5	2.35	2.25	2.09	1.97	1.86	1.79	1.76
NOx	3.42	3.19	2.85	2.36	2.11	1.95	1.88

District Rule 4308 Description

The purpose of this rule is to limit NOx and CO emissions from units within this source category. As a point-of-sale rule, Rule 4308 achieves emissions reductions as operators with units subject to the rule replace their equipment over time. This point-of-sale approach allows the District to achieve NOx emission reductions without forcing immediate replacement of existing units to comply with rule requirements and thus placing an undo financial burden on the consumer. This rule has resulted in more than 93% control of emissions from this source category.

The District adopted Rule 4308 on October 20, 2005, to establish NOx emissions limits for units that were previously exempt from District regulations because of their small size. The rule was amended in December 2009 to lower the NOx emissions limits to 20 ppmv for units fired on natural gas, with the exception of instantaneous water heaters and pool heaters greater than or equal to 0.075 MMBtu/hr but less than or equal to 0.4 MMBtu/hr. The District subsequently amended Rule 4308 in 2013 to lower the NOx emission limit for instantaneous water heaters 0.075 MMBtu/hr to 0.4 MMBtu/hr to 20 ppmv.

How does District Rule 4308 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Techniques Guidelines or New Source Performance Standards applicable to this source category.

A. Alternative Control Techniques (ACT)

ACTs address potential emission control techniques for units with the potential to emit more than 25 tons of NOx per year. No units subject to District Rule 4308 have the potential to emit 25 tons per year; therefore, ACTs are not directly applicable to this source category. However, ACTs do discuss various control technologies, so the District has examined them.

- *Alternative Control Techniques Document – NOx Emissions from Process Heaters) (EPA-453/R-93-034 1993/09)*

The District evaluated the ACT for NOx Emissions from Process Heaters and found no applicable control requirements. As such, Rule 4308 is more stringent.

- *Alternative Control Techniques Document – NOx Emissions from Industrial/Commercial/Institutional Boilers (EPA-453/R-94-022 1994/03)*

The District evaluated the ACT for NOx Emissions from Industrial/Commercial/Institutional Boilers and found no applicable control techniques that were more stringent than those already in Rule 4308.

- *Alternative Control Techniques Document – NOx Emissions from Utility Boilers (EPA-453/R-94-023 1994/06)*

The District evaluated the ACT for NOx Emissions from Utility Boilers and found no applicable control techniques that were more stringent than those already in Rule 4308.

State Regulations

There are no state regulations that apply to this source category.

How does District Rule 4308 compare to rules in other air districts?

The District compared the emission limits, optional control requirements, and work practice standards in District Rule 4308 to comparable requirements in rules from the following California nonattainment areas:

- Bay Area AQMD Regulation 9, Rule 6 (Amended March 15, 2023)[74]
- Bay Area AQMD Regulation 9, Rule 7 (Amended May 4, 2011)[75]
- Bay Area AQMD Regulation 9, Rule 10 (Amended November 3, 2021)[76]

[74] BAAQMD. *Regulation 9, Rule 6 (Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters).* (Amended March 15, 2023). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-4-nitrogen-oxides-from-fan-type-residential-central-furnaces/2021-amendments/documents/20230315_rg0906-pdf.pdf?la=en

[75] BAAQMD. *Regulation 9, Rule 7 (Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters).* (Amended May 4, 2011). Retrieved from: https://www.baaqmd.gov/rules-and-compliance/rules/reg-9-rule-7-nitrogen-oxides-and-carbon-monoxide-from-industrial-institutional-and-commercial-boiler

[76] BAAQMD. *Regulation 9, Rule 10 (Nitrogen Oxides and Carbon Monoxide from Boilers, Steam Generators, and Process Heaters in Petroleum Refineries).* (Amended November 3, 2021). Retrieved from: https://www.baaqmd.gov/rules-and-compliance/rules/reg-9-rule-10-nitrogen-oxides-and-carbon-monoxide-from-boilers-steam-generators-and-process-heaters

- Sacramento Metropolitan AQMD Rule 411 (Amended August 23, 2007)[77]
- Sacramento Metropolitan AQMD Rule 414 (Amended October 25, 2018)[78]
- San Diego County APCD Rule 69.2.1 (Adopted July 8, 2020)[79]
- South Coast AQMD Rule 1146.2 (Amended December 7, 2018)[80]
- Ventura County APCD Rule 74.11.1 (Amended September 11, 2012)[81]
- Ventura County APCD Rule 74.15.1 (Amended June 23, 2015)[82]

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4308 continues to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rules is demonstrated below.

Bay Area AQMD

- BAAQMD Regulation 9, Rule 6 (Natural Gas-Fired Boilers and Water Heaters)

	SJVAPCD Rule 4308	BAAQMD Reg 9, Rule 6
Applicability	Boilers, steam generators and process heaters with rated heat input capacity ≥0.075 MMBtu/hr and <2 MMBtu/hr.	Any person who sells, installs, or offers for sale a natural gas-fired water heater and any manufacturer who intends to sell or distribute for sale or installation a natural gas-fired water heater.
Exemptions	• Units installed in manufactured homes • Units installed in recreational vehicles • Hot water pressure washers	• Units with rated heat input capacity >2 MMBtu/hr • Units used in recreational vehicles • Water heaters using a fuel other than natural gas • Natural gas-fired pool/spa heaters with <0.4 MMBtu/hr rated heat input capacity used exclusively to heat swimming pools, hot tubs or spas
Requirements	***NOx Emission Limits:** <u>Units ≥0.075 to ≤0.4 MMBtu/hr (except instantaneous water heater and pool heaters below)</u>: • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu)	***NOx Emission Limits:** <u>Natural gas-fired boilers and instantaneous water heaters >0.075 to ≤0.4 MMBtu/hr</u>: • 14 ng/J (20 ppmv) for units manufactured after Jan. 1, 2013; • 0.0 ng/J of heat output for units manufactured after Jan. 1, 2031

[77] SMAQMD. *Rule 411 (NOx from Boilers, Process Heaters, and Steam Generators)*. (Amended August 23, 2007). Retrieved from: http://www.airquality.org/ProgramCoordination/Documents/rule411.pdf
[78] SMAQMD. *Rule 414 (Water Heaters, Boilers, and Process Heaters Rated Less Than 1,000,000 BTU Per Hour)*. (Amended October 25, 2018). Retrieved from: http://www.airquality.org/ProgramCoordination/Documents/rule414.pdf
[79] SDAPCD. *Rule 69.2.1 (Small Boilers, Process Heaters, Steam Generators, and Large Water Heaters)*. (Adopted July 8, 2020). Retrieved from: https://www.sdapcd.org/content/dam/sdapcd/documents/rules/current-rules/Rule-69.2.1.pdf
[80] SCAQMD. *Rule 1146.2 (Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters)*. (Amended December 7, 2018). Retrieved from: http://www.aqmd.gov/home/rules-compliance/rules/support-documents/rule-1146-2-details
[81] VCAPCD. *Rule 74.11.1 (Large Water Heaters and Small Boilers)*. (Amended September 11, 2012). Retrieved from: http://vcapcd.org/Rulebook/Reg4/RULE%2074.11.1.pdf
[82] VCAPCD. *Rule 74.15.1 (Boilers, Steam Generators, and Process Heaters)*. (Amended June 23, 2015). Retrieved from: http://www.vcapcd.org/Rulebook/Reg4/RULE%2074.15.1.pdf

	SJVAPCD Rule 4308	BAAQMD Reg 9, Rule 6
	Units >0.4 to <2 MMBtu/hr (except instantaneous water heater and pool heaters below): • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 30 ppmv (0.036 lb/MMBtu) Instantaneous water heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu) Instantaneous water heaters >0.4 to <2 MMBtu/hr: • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu) Pool heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas: 55 ppmv (0.068 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu) Pool heaters >0.4 to <2 MMBtu/hr: • PUC gas: 20 ppmv (0.068 lb/MMBtu); • Non-PUC or liquid: 30 ppmv (0.036 lb/MMBtu)	Natural gas-fired boilers and instantaneous water heaters >0.4 to ≤2 MMBtu/hr: • 14 ng/J (20 ppmv) for units manufactured after Jan. 1, 2013; • 0.0 ng/J of heat output for units manufactured after Jan. 1, 2031 Natural gas-fired pool/spa heaters >0.4 to ≤2 MMBtu/hr: • 14 ng/J (20 ppmv) for units manufactured after Jan. 1, 2013

*Unless otherwise stated, all ppmv values in the table are ppmv @ 3% O2

BAAQMD Regulation 9, Rule 6 regulates NOx and CO emissions from natural gas-fired boilers and water heaters. The District compared the emission limits in District Rule 4308 and BAAQMD's Regulation 9, Rule 6 and concluded that NOx emission limits in the District rule are equivalent to the BAAQMD rule limits for similarly rated units at this time. For units manufactured after January 1, 2031, BAAQMD's NOx limit will be more stringent than SJVAPCD Rule 4308 limit for natural gas-fired boilers and water heaters rated at greater than 0.075 to 2 MMBtu/hr. Notably, this limit takes effect well beyond the 2025 date by which the District is required to implement BACM. BAAQMD selected this future compliance date for the zero-NOx limit due to the current lack of available zero-emission technologies, and the complexities of installations of units in this category. For these reasons, BAAQMD's future limit cannot be considered as establishing BACM at this time.

- BAAQMD Regulation 9, Rule 10 (Boilers, Steam Generators and Process Heaters in Refineries)

BAAQMD amended Regulation 9, Rule 10 on November 3, 2021. The 2021 amendments were administrative and did not affect the stringency of rule requirements implemented prior to EPA's approval of the District meeting BACM/MSM for the *2018*

PM2.5 Plan. The District found no requirements in BAAQMD Regulation 9, Rule 10 that were more stringent than those in Rule 4308.

Sacramento Metropolitan AQMD

- SMAQMD Rule 414 (Water Heaters, Boilers and Process Heaters Rated Less than 1 MMBtu/hr)

	SJVAPCD Rule 4308	SMAQMD Rule 414
Applicability	Boilers, steam generators and process heaters with rated heat input capacity ≥0.075 MMBtu/hr and <2 MMBtu/hr.	Boilers, steam generators, and process heaters fired on gaseous or non-gaseous fuels with a rated capacity <1 MMBtu/hr.
Exemptions	• Units installed in manufactured homes • Units installed in recreational vehicles • Hot water pressure washers	• Water heaters in recreational vehicles • Pool/spa heaters <0.075 MMBtu/hr • Water heaters, boilers and process heater fired on LPG fuel • Hot water pressure washers fired with gaseous or liquid fuels
Requirements	***NOx Emission Limits:** Units ≥0.075 to ≤0.4 MMBtu/hr (except instantaneous water heater and pool heaters below): • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu) Units >0.4 to <2 MMBtu/hr (except instantaneous water heater and pool heaters below): • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 30 ppmv (0.036 lb/MMBtu) Instantaneous water heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu) Instantaneous water heaters >0.4 to <2 MMBtu/hr: • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu) Pool heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas: 55 ppmv (0.068 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu) Pool heaters >0.4 to <2 MMBtu/hr: • PUC gas: 20 ppmv (0.068 lb/MMBtu); • Non-PUC or liquid: 30 ppmv (0.036 lb/MMBtu)	***NOx Emission Limits:** Units ≥0.075 to <0.4 MMBtu/hr: • Pool/spa units: 40 ng/J (55 ppmv); • All other units: 14 ng/J (20 ppmv) Units ≥0.4 to <1 MMBtu/hr: • 14 ng/J (20 ppmv)

*Unless otherwise stated, all ppmv values in the table are ppmv @ 3% O2

The District evaluated the requirements contained within SMAQMD Rule 414, and found no requirements to be more stringent than those already in District Rule 4308. Therefore, District Rule 4308 is as stringent as or more stringent than SMAQMD Rule 414.

San Diego County APCD

- SDAPCD Rule 69.2.1 (Small Boilers, Process Heaters, Steam Generators, and Large Water Heaters)

	SJVAPCD Rule 4308	SDAPCD Rule 69.2.1
Applicability	Boilers, steam generators and process heaters with rated heat input capacity ≥0.075 MMBtu/hr and <2 MMBtu/hr.	Any person who manufactures, sells, offers for sale or distributes, or installs a new boiler, process heater, steam generator, or water heater with a heat input rating 75,000 Btu/hr to 2 MMBu/hr.
Exemptions	• Units installed in manufactured homes • Units installed in recreational vehicles • Hot water pressure washers	• Waste heat recovery boilers used to recover heat from the exhaust of gas turbines, internal combustion engines, or other combustion equipment • Furnaces, kilns, and any combustion equipment where the material being heated is in direct contact with the products of combustion • Thermal oxidizers and associated waste heat recovery equipment • Hot water pressure washers
Requirements	***NOx Emission Limits:** <u>Units ≥0.075 to ≤0.4 MMBtu/hr (except instantaneous water heater and pool heaters below)</u>: • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu) <u>Units >0.4 to <2 MMBtu/hr (except instantaneous water heater and pool heaters below)</u>: • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 30 ppmv (0.036 lb/MMBtu) <u>Instantaneous water heaters ≥0.075 to ≤0.4 MMBtu/hr</u>: • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu) <u>Instantaneous water heaters >0.4 to <2 MMBtu/hr</u>: • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu) <u>Pool heaters ≥0.075 to ≤0.4 MMBtu/hr</u>: • PUC gas: 55 ppmv (0.068 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu)	***NOx Emission Limits:** <u>Units ≥0.075 to ≤0.4 MMBtu/hr (except pool heaters)</u>: • PUC gas: 20 ppmv; • Non-PUC or liquid: 77 ppmv <u>Units >0.4 to <2 MMBtu/hr (except pool heaters)</u>: • PUC gas: 20 ppmv; • Non-PUC or liquid: 30 ppmv <u>Pool heaters ≥0.075 to ≤0.4 MMBtu/hr</u>: • PUC gas: 55 ppmv

	SJVAPCD Rule 4308	SDAPCD Rule 69.2.1
	Pool heaters >0.4 to <2 MMBtu/hr: • PUC gas: 20 ppmv (0.068 lb/MMBtu); • Non-PUC or liquid: 30 ppmv (0.036 lb/MMBtu)	

*Unless otherwise stated, all ppmv values in the table are ppmv @ 3% O2

The District evaluated the requirements contained within SDAPCD Rule 69.2.1 and found no requirements to be more stringent than those already in District Rule 4308. Therefore, District Rule 4308 is as stringent as or more stringent than SDAPCD Rule 69.2.1.

South Coast AQMD

- SCAQMD Rule 1146.2 (Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters)

	SJVAPCD Rule 4308	SCAQMD 1146.2
Applicability	Boilers, steam generators and process heaters with rated heat input capacity ≥0.075 MMBtu/hr and <2 MMBtu/hr.	Natural gas-fired water heaters, boilers and process heaters with rated heat input capacity of ≤2 MMBtu/hr.
Exemptions	• Units installed in manufactured homes • Units installed in recreational vehicles • Hot water pressure washers	• Units used in recreational vehicles • Units subject to SCAQMD Rule 1121 (Control of NOx from Residential Type, Natural Gas-Fired Water Heaters) - applies to units rated at <0.075 MMBtu/hr • Units at a RECLAIM or former RECLAIM facility subject to a NOx limit in a different rule • Units at municipal sanitation service facility subject to a NOx limit in Reg XI adopted or amended after 12/07/18 • Exempt from some rule requirements: ○ Any residential unit* ○ Units with >0.4 and ≤2 MMBtu/hr, demonstrated to use <9,000 therms during every calendar year
Requirements	***NOx Emission Limits:** Units ≥0.075 to ≤0.4 MMBtu/hr (except instantaneous water heater and pool heaters below): • PUC gas: 20 ppmv (0.024 lb/MMBtu) Units >0.4 to <2 MMBtu/hr (except instantaneous water heater and pool heaters below): • PUC gas: 20 ppmv (0.024 lb/MMBtu) Instantaneous water heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas: 20 ppmv (0.024 lb/MMBtu)	***NOx Emission Limits:** Units >0.4 to ≤2 MMBtu/hr: • 14 ng/J (20 ppmv) Units ≤0.4 MMBtu/hr (except pool heaters): • 14 ng/J (20 ppmv)

	SJVAPCD Rule 4308	SCAQMD 1146.2
	Instantaneous water heaters >0.4 to <2 MMBtu/hr: • PUC gas: 20 ppmv (0.024 lb/MMBtu) Pool heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas: 55 ppmv (0.068 lb/MMBtu) Pool heaters >0.4 to <2 MMBtu/hr: • PUC gas: 20 ppmv (0.068 lb/MMBtu)	

*Unless otherwise stated, all ppmv values in the table are ppmv @ 3% O2

The District evaluated the requirements contained within SCAQMD Rule 1146.2, and found no requirements to be more stringent than those already in District Rule 4308. Therefore, District Rule 4308 is as stringent as or more stringent than SCAQMD Rule 1146.2.

Ventura County APCD

- VCAPCD Rule 74.15.1 (Boilers, Steam Generators, and Process Heaters)

	SJVAPCD Rule 4308	VCAPCD Rule 74.15.1
Applicability	Boilers, steam generators and process heaters with rated heat input capacity ≥0.075 MMBtu/hr and <2 MMBtu/hr.	Any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a rated heat input capacity ≥1 MMBtu/hr and <5 MMBtu/hr.
Exemptions	• Units installed in manufactured homes • Units installed in recreational vehicles • Hot water pressure washers	• Any unit operated on alternate fuel under following conditions: ○ Alternate fuel use required due to natural gas curtailment period. ○ Alternative fuel use is required to maintain the alternate fuel system, and in this case use shall not exceed 50 hr/yr • Portable oil well dewaxing process heater is not subject to 30 ppmv NOx, if annual heat input rate is <2.8 billion Btu
Requirements	***NOx Emission Limits:** Units ≥0.075 to ≤0.4 MMBtu/hr (except instantaneous water heater and pool heaters below): • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu) Units >0.4 to <2 MMBtu/hr (except instantaneous water heater and pool heaters below): • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 30 ppmv (0.036 lb/MMBtu) Instantaneous water heaters ≥0.075 to ≤0.4 MMBtu/hr:	***NOx Emission Limits:** Units ≥1.8 billion Btu/yr: • 30 ppmv Units ≥1 to ≤2 MMBtu/hr: • 20 ppmv (natural gas-fired) Units ≥0.3 billion Btu/yr and <1.8 billion Btu/yr: Comply with one of the following: • Units shall be tuned every 6 months or after 750 hours of operation, but not less than once per calendar year; OR • The unit shall comply with the emission and testing requirements

	SJVAPCD Rule 4308	VCAPCD Rule 74.15.1
	• PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu) Instantaneous water heaters >0.4 to <2 MMBtu/hr: • PUC gas: 20 ppmv (0.024 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu) Pool heaters ≥0.075 to ≤0.4 MMBtu/hr: • PUC gas: 55 ppmv (0.068 lb/MMBtu); • Non-PUC or liquid: 77 ppmv (0.093 lb/MMBtu) Pool heaters >0.4 to <2 MMBtu/hr: • PUC gas: 20 ppmv (0.068 lb/MMBtu); • Non-PUC or liquid: 30 ppmv (0.036 lb/MMBtu)	

*Unless otherwise stated, all ppmv values in the table are ppmv @ 3% O2

The District evaluated the requirements contained within VCAPCD Rule 74.15.1, and found no requirements to be more stringent than those already in District Rule 4308. Therefore, District Rule 4308 is as stringent as or more stringent than VCAPCD Rule 74.15.1.

Potential Emission Reduction Opportunities

Beyond the review of current regulations and rule requirements, the District has evaluated the feasibility of technologies and measures implemented in other regions and potential new technologies and measures that may be feasible for implementation in the near future.

NOx Emission Control Technologies

Use of SCR system

SCR technology is predominantly used to reduce NOx emissions from large boilers, steam generators, and process heaters. Presuming units between 0.075 to <2 MMBtu/hr can be equipped with SCR system, the total annualized cost of deploying such technology would be at least $33,613 per year.[83]

Assuming an SCR system reliably reduces NOx emissions from 20 ppmv @ 3% O2 to 5 ppmv @ 3% O2 for a 1.99 MMBtu/hr unit that operates 8,760 hours per year, the potential reductions would be 310 lb/year[84] (0.155 tons-NOx/yr).

The cost of achieving these potential NOx reductions would be at least $216,858/ton of emissions reduced. As such, this technology is not cost effective for reducing emissions from this category.

[83] See Rule 4307 control measure analysis. Note that there is no significant price difference for an SCR system on 2-5 MMBtu/hr unit or smaller units.
[84] Potential NOx reduction = (0.024-0.0062) lb-NOx/MMBtu x 1.99 MMBtu/hr x 8,760 hr/yr = 310 lb-NOx/yr

Use of ULNB technology

ULNBs can reliably achieve at least 9 ppmv NOx @ 3% O2 and are available for units rated between 2-5 MMBtu/hr. Presuming that this technology is also available for small size boilers for a given application, a unit may be equipped with a ULNB system. Per a local vendor, the cost of a 2 MMBtu/hr boiler would be $35,000 for a hot water boiler. The cost effectiveness analysis is included below for this technology.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE):			
Burner system	A	$35,000	Local vendor
Instrumentation and controls	0.01 A	$350	OAQPS
Sales taxes	0.08 A	$2,828	
Freight	0.05 A	$1,750	OAQPS
Purchased equipment cost, PEC		$39,928	
Direct installation costs (DI):			
Foundation & supports	0.08 B	$3,194	See footnote
Handling and erection	0.14 B	$5,590	OAQPS
Electrical	0.04 B	$1,597	OAQPS
Piping	0.02 B	$799	OAQPS
Insulation and ductwork:	0.01 B	$399	OAQPS
Painting	0.01 B	$399	OAQPS
Direct installation costs		$51,906	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC		$51,906	

Description of Cost	Cost Factor	Cost	Source
Indirect Costs (Installation)			
Engineering	0.10 B	$3,993	OAQPS
Construction and field expenses	0.05 B	$1,996	OAQPS
Contractor fees	0.10 B	$3,993	OAQPS
Contingencies	0.03 B	$1,198	OAQPS
Start-up	0.02 B	$799	OAQPS
Performance test	0.01 B	$399	OAQPS
Total indirect costs, IC	0.31 B	$12,378	
Total Capital Investments (TCI = DC + IC):		**$64,284**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**$10,459**	
Direct annual costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance costs (labor and material)	--	--	
Electricity cost	$0.08848/kWH	--	Not estimated
Indirect Annual Costs (IAC)			
Overhead	--	--	See table footnote
Insurance	--	--	See table footnote
Property Tax	--	--	See table footnote
Administrative	--	--	See table footnote
Total Annual Cost (DAC + IAC)		--	
Total annual cost (Annualized TCI + Total annual cost)		**$10,459**	

*Direct annual cost and indirect annual costs are presumed insignificant for new units and will likely be same when existing unit is being replaced

Assuming a ULNB system reliably reduces NOx emissions from 20 ppmv @ 3% O2 to 9 ppmv @ 3% O2 for a 1.99 MMBtu/hr unit that operates 8,760 hours per year, the potential reductions would be 227 lb/year[85] (0.114 tons-NOx/yr).

The cost of achieving these potential NOx reductions would be at least $91,746/ton of emissions reduced. As such, this technology is not cost effective for reducing emissions from this category.

Use of EMx System

The District researched post-combustion controls such as EMx, the second generation of the SCONOx technology that reduces NOx, SOx, CO, and VOC emissions. Per EmeraChem, manufacturer/vendor of the technology, this technology has not been AIP for natural gas fired boilers. SCONOx and EMx systems have only been used by power plants for the control of turbine emissions. The cost of an EMx system would be anywhere from $3 to $5 million or even up to $8 million in some cases for large power plant installations. Moreover, the EMx system is ideal for new installation, but becomes extremely challenging and sometimes nearly impossible to retrofit to an existing unit. In fact, cost effectiveness analyses conducted by the District for the installation of SCONOx/EMx units on large power plant turbine installations within the Valley have shown that this technology is not cost effective. Given the high cost effectiveness demonstrated for turbines and lack of demonstrated practice with boilers, especially very small boilers such as those covered by this rule, this technology is not feasible or cost effective for reducing emissions from this category.

PM2.5 Emission Control Technologies

The majority of units 0.075 to less than 2 MMBtu/hr in the Valley combust PUC quality natural gas; PUC quality natural gas contains a very low sulfur content and inherently has low emissions. Few boilers in the Valley use alternative fuels for their combustion processes, which include digester gas, produced gas, and liquid fuel. Units fired on digester gas or produced gas are already required to use inlet gas scrubbers to meet District rule requirements. The District also explored the feasibility of adding PM2.5 limits for units using liquid fuel to reduce PM emissions as part of this comprehensive control measure evaluation.

The District evaluated three technologies as potential control options for reducing PM emissions: baghouses, ESPs, and wet scrubbers. Baghouses control total PM and PM2.5 emissions by 90-99%; ESPs control total PM and PM2.5 emissions by 90-99%; and wet scrubbers control large particulates (>PM5) by 99% and PM2.5 emissions by approximately 50%. Baghouses are typically not used with liquid-fired boilers due to the potential clogging of the baghouse and are therefore not a recommended technology

[85] Potential NOx reduction = (0.024 – 0.011) lb-NOx/MMBtu x 1.99 MMBtu/hr x 8,760 hr/yr = 227 lb-NOx/yr

due to infeasibility and safety issues.[86] Furthermore, the District is unaware of installations of these types of controls on the small boilers covered by this regulation, generally due to the extraordinary cost associated with doing so. See below for cost and cost effectiveness calculations for the other two technologies.

Potential Emissions Reductions

The District calculated the potential PM emissions reductions that could result from the use of an ESP and scrubber. For the purposes of these calculations, the following assumptions were made:

1. For simplicity, the analysis will evaluate the cost effectiveness of these technologies for total PM reductions from liquid fuel fired units.
2. The PM combustion EF = 0.024 lb/MMBtu, based on maximum permitted EF for boilers 2-5 MMBtu/hr with option to use diesel fuel during natural gas curtailment.
3. Max rating of burner = 1.99 MMBtu/hr and assumed to operate 8,760 hours/yr.
4. The PM control efficiency of an ESP is 99%.
5. The PM control efficiency of a scrubber is 99%.
6. Due to lack of units in the Valley, the analysis is based on one known unit.

The potential PM emissions reductions were calculated as follows:

Potential Emissions Reductions $_{(ESP)}$ = (PM Emissions) x (Control Efficiency)
Potential Emissions Reductions $_{(ESP)}$ = (0.024 lb-PM/MMBtu x 1.99 MMBtu/yr x 8,760 hr/yr x ton/2,000 lb) tons/year x 0.99
Potential Emissions Reductions $_{(ESP)}$ = 0.209 tons/yr x 0.99
Potential Emissions Reductions $_{(ESP)}$ = 0.207 tons/year

Potential Emissions Reductions $_{(scrubber)}$ = (PM Emissions) x (Control Efficiency)
Potential Emissions Reductions $_{(scrubber)}$ = 0.209 tons/year x 0.99
Potential Emissions Reductions $_{(scrubber)}$ = 0.207 tons/year

Annualized Cost

The capital cost for the installation of an ESP for a 1-5 MMBtu/hr boiler ranges from \$90,000-\$100,000 and the annual maintenance cost ranges from \$1,000-\$2,000.[87] For the wet scrubber system, EPA estimated the annualized cost at \$5,300-\$102,000 per sm^3/sec at an average air flow rate of 0.7-47 sm^3/sec.[88] The following assumptions were made for this analysis:

1. The capital cost of an ESP is assumed to be the median of the range above (\$95,000).

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[86] Northeast States for Coordinated Air Use Management. *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* (November 2008). Retrieved from: https://www.nescaum.org/documents/ici-boilers-20081118-final.pdf

[87] Catherine Roberts. (March 2009). *Information on Air Pollution Control Technology for Woody Biomass Boilers.* Environmental Protection Agency Office of Air Quality Planning and Standards and Northeast States for Coordinated Air Use Management.

[88] EPA. (2002). *Air Pollution Control Technology Fact Sheet: Spray-Chamber/Spray-Tower Wet Scrubber.* Retrieved from: http://www.epa.gov/ttncatc1/dir1/fsprytwr.pdf

2. The annual maintenance cost of an ESP is assumed to be the median of the range above ($1,500).
3. The annualized cost of a wet scrubber system is assumed to be the median of the range above ($53,650 per sm^3/sec).
4. The average air flow rate for a wet scrubber system is assumed to be the median of the range above (23.85 sm^3/sec).
5. The total capital and maintenance cost of an ESP will be calculated by multiplying the cost of 1 unit by the total number of units.
6. The total annualized cost of a wet scrubber will be calculated by multiplying the annualized cost of 1 unit by the total number of units.
7. Lifetime of the ESP is 10 years at 10% interest. To account for this, the annualized capital cost will be calculated by multiplying the total capital cost by the capital recovery factor of 0.1627 and adding the annual maintenance costs.

The annualized cost of an ESP and Wet Scrubber was calculated as follows:

Annual Cost $_{(ESP)}$ = (Total Capital Cost) x (0.1627) + (Annual Maintenance Cost)
Annual Cost $_{(ESP)}$ = ($95,000 x 1) x (0.1627) + ($1,500 x 1)
Annual Cost $_{(ESP)}$ = $16,957/year

Annual Cost $_{(scrubber)}$ = (Annualized Cost of 1 unit) x (Number of Units) x (Average Flow Rate)
Annual Cost $_{(scrubber)}$ = ($53,650/ sm^3/sec) x (1) x (23.85 sm^3/sec)
Annual Cost $_{(scrubber)}$ = $1,279,553/year

<u>Cost Effectiveness</u>
The cost effectiveness of an ESP and Wet Scrubber was calculated as follows:

Cost effectiveness = Annual Cost / Annual Emissions Reductions

Cost effectiveness $_{(ESP)}$ = ($16,957/year) / (0.207 tons/year)
Cost effectiveness $_{(ESP)}$ = $81,918/ton of PM

Cost effectiveness $_{(scrubber)}$ = ($1,279,553/year) / (0.207 tons/year)
Cost effectiveness $_{(scrubber)}$ = $6,181,413/ton of PM

As illustrated above, neither PM control technology is cost effective. Furthermore, the above calculations for ESP technology did not include costs of retrofitting equipment and/or the facility or compliance monitoring, thus the total costs for implementing this technology would be even higher than what is estimated here. The District concludes that this is not a feasible control measure for this source category.

Other Potential Opportunities

In an effort to identify potential emission reduction opportunities, the District's *2022 Ozone Plan* includes a further study commitment to evaluate current and upcoming work from CARB and other agencies related to reducing emissions from residential and commercial combustion sources, and evaluate the feasibility of implementing zero-emission or low-NOx requirements for these sources in the Valley. Through this effort, the District will also evaluate opportunities to advocate for funding under the Inflation Reduction Act, Bipartisan Infrastructure Law, and other funding sources, which are prioritizing funding opportunities for electrification of appliances to reduce greenhouse gas emissions. The District will continue to closely track regulations being developed by CARB, SCAQMD, BAAQMD, and others. Additionally, although the District currently implements BACM for this source category, the District remains committed to pursuing electrification opportunities, taking into consideration equitable and feasible strategies.

Based on this review, the District did not identify additional emission reduction opportunities for this source category at this time.

Evaluation Findings

Rule 4308 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.10 RULE 4309 (DRYERS, DEHYDRATORS, AND OVENS)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	0.78	0.77	0.76	0.75	0.74	0.74	0.74
NOx	0.29	0.29	0.29	0.28	0.28	0.28	0.28
	Winter Average - Tons per day						
PM2.5	0.78	0.77	0.76	0.74	0.73	0.73	0.74
NOx	0.26	0.26	0.26	0.26	0.25	0.25	0.25

District Rule 4309 Description

The District adopted Rule 4309 on December 15, 2005, to limit NOx and CO emissions from dryers, dehydrators, or ovens fired on gaseous, liquid, or gaseous and liquid fuel sequentially that have a total rated heat input for the unit of 5.0 MMBtu/hr or greater. The rule limits NOx emissions to between 3.5-12 ppmv for four categories of equipment. The adoption of Rule 4309 has considerably reduced NOx emissions from this source category.

How does District Rule 4309 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Techniques Guidelines or New Source Performance Standards applicable to this source category.

A. Alternative Control Techniques (ACT)

- *Alternative Control Techniques Document – NOx Emissions from Cement Manufacturing (EPA-453/R-94-004 1994/03)*

The District evaluated the requirements contained within the ACT for NOx Emissions from Cement Manufacturing and found no applicable requirements that would be more stringent than those already in Rule 4309.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4309 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4309 to comparable requirements in rules from the following California nonattainment areas:

- Sacramento Metropolitan AQMD Rule 419 (Amended October 25, 2018)[89]
- South Coast AQMD Rule 1147 (Amended May 6, 2022)[90]
- South Coast AQMD Rule 1147.1 (Adopted August 6, 2021)[91]
- Ventura County APCD Rule 74.34 (Adopted December 13, 2016)[92]

Bay Area AQMD does not have an analogous rule for this source category.

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4309 continues to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rules is demonstrated below.

Sacramento Metropolitan AQMD

- SMAQMD Rule 419 (NOx from Miscellaneous Combustion Units)

	SJVAPCD Rule 4309	SMAQMD Rule 419
Applicability	Dryer, dehydrator, or oven that is fired on gaseous fuel, liquid fuel, or is fired on gaseous and liquid fuel sequentially, and the total rated heat input for the unit is ≥5 MMBtu/hr.	Any misc. combustion units and cooking units with a total rated heat input capacity of ≥2 MMBtu/hr located at a major stationary source of NOx, and any misc. combustion unit or cooking unit with a total rated heat input capacity of ≥5 MMBtu/hr not located at a major stationary source of NOx.
Exemptions	• Column-type or tower dryers used to dry grains, or tree nuts • Units to pre-condition onions or garlic prior to dehydration • Smokehouses or units used for roasting • Units to bake or fry food for human consumption • Charbroilers • Units used to dry lint cotton or cotton at cotton gins • Units with no stack for the exhaust gas and one or more sides open to the atmosphere	• Operations subject to SMAQMD rules for: ○ Boilers, process heaters, and steam generators ○ Stationary IC engines at major sources ○ Stationary gas turbines ○ Water heaters, boilers, and process heaters <1 MMBtu/hr • Units exempt from SMAQMD general permit requirements • Air pollution control devices • Duct burners • Specific combustion units: ○ Any unit that is used exclusively by an electric utility to generate electricity

[89] SMAQMD. *Rule 419 (NOx from Miscellaneous Combustion Units)*. (Amended October 25, 2018). Retrieved from: http://www.airquality.org/ProgramCoordination/Documents/rule419.pdf
[90] SCAQMD. *Rule 1147 (NOx Reductions from Miscellaneous Sources)*. (Amended July 7, 2017). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1147.pdf?sfvrsn=4
[91] SCAQMD. *Rule 1147.1 (NOx Reductions from Aggregate Dryers)*. (Adopted August 6, 2021). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1147-1.pdf?sfvrsn=7
[92] VCAPCD. *Rule 74.34 (NOx Reductions from Miscellaneous Sources)*. (Adopted December 13, 2016). Retrieved from: http://www.vcapcd.org/Rulebook/Reg4/RULE%2074.34.pdf

	SJVAPCD Rule 4309		SMAQMD Rule 419	
	• Units subject to District Rules 4305, 4306, 4307, or 4351		○ Gas flares ○ Internal combustion engines ○ Cooking units ○ Crematories ○ Dryers used in asphalt manufacturing operations ○ Furnaces ○ Incinerators ○ Kilns ○ Roasters	
Requirements (NOx Limits)	**Gaseous Fuel-Fired Equipment**			
	ppmv corrected to 19% O2, dry unless otherwise specified		ppmv corrected to 3% O2, dry unless otherwise specified	
	Dehydrators	-	Dehydrator, Dryer, Heater, or Oven	<u><1,200°F</u> 30 ppmv or 0.036 lb/MMBtu (3.3 ppmvd @ 19% O2) <u>≥1,200°F</u> 60 ppmv or 0.073 lb/MMBtu (6.5 ppmvd @ 19% O2)
	Asphalt/Concrete Plants	4.3 ppmv (0.0492 lb/MMBtu)	-	-
	Milk, Cheese and Dairy Processing (<20 MMBtu/hr)	3.5 ppmv (0.04 lb/MMBtu)	-	-
	Milk, Cheese and Dairy Processing (≥20 MMBtu/hr)	5.3 ppmv (0.061 lb/MMBtu)		
	Other processes not described above	4.3 ppmv (0.0492 lb/MMBtu)	-	-
	Liquid Fuel-Fired Equipment			
	All Liquid Fuel-Fired Units	Varies from 3.5 ppmv to 12 ppmv (0.04 lb/MMBtu to 0.14 lb/MMBtu)	All misc. combustion units when liquid fuel-fired	<u><1,200°F</u> 40 ppmv or 0.051 lb/MMBtu (4.3 ppmvd @ 19% O2) <u>≥1,200°F</u> 60 ppmv or 0.073 lb/MMBtu (6.5 ppmvd @ 19% O2)

SMAQMD Rule 419 establishes emission limits based on the process temperature and does not consider the equipment categories, whereas District Rule 4309 does not consider the process temperature and instead establishes emissions limits based on the equipment categories. Under SMAQMD's Rule 419, the NOx limits vary from 3.3 to 6.5 ppmv at 19% O2 with an average of 4.9 ppmv, while District Rule 4309 limits NOx emissions from 3.5 to 5.3 ppmv with most categories limited to 4.3 ppmv at 19% O2, independent of the process temperature. Overall, District Rule 4309 is as stringent as or more stringent than SMAQMD Rule 419.

South Coast AQMD

- SCAQMD Rule 1147 (NOx Reductions from Miscellaneous Sources)

<table>
<tr><th></th><th colspan="2">SJVAPCD Rule 4309</th><th colspan="2">SCAQMD Rule 1147</th></tr>
<tr><td>Applicability</td><td colspan="2">Dryer, dehydrator, or oven that is fired on gaseous fuel, liquid fuel, or is fired on gaseous and liquid fuel sequentially, and the total rated heat input for the unit is ≥5 MMBtu/hr.</td><td colspan="2">Manufacturers, distributors, retailers, installers, owners, and operators of gaseous and/or liquid fuel fired combustion equipment with NOx emissions that require a SCAQMD permit and when other SCAQMD Regulation XI rules are not applicable to the unit.</td></tr>
<tr><td>Exemptions</td><td colspan="2">• Column-type or tower dryers used to dry grains, or tree nuts
• Units to pre-condition onions or garlic prior to dehydration
• Smokehouses or units used for roasting
• Units to bake or fry food for human consumption
• Charbroilers
• Units used to dry lint cotton or cotton at cotton gins
• Units with no stack for the exhaust gas and one or more sides open to the atmosphere
• Units subject to District Rules 4305, 4306, 4307, or 4351</td><td colspan="2">• Units rated <325,000 Btu/hr
• Charbroilers or food ovens
• Flares subject to SCAQMD Rules 1118 or 1118.1
• Flares, afterburners, degassing units, thermal or catalytic oxidizers or vapor incinerators in which a fuel is used only to maintain a pilot for vapor ignition or is used for ≤5 minutes to bring a unit up to Minimum Operating Temperature
• Municipal solid waste incinerators with permit operating before 12/05/08
• Afterburner or vapor incinerator with permit operating before 12/05/08 that has an integrated thermal fluid heat exchanger that captures heat from the afterburner or vapor incinerator and an oven or furnace exhaust in order to reduce fuel consumption by an oven or the afterburner or vapor incinerator
• Flare, afterburner, degassing unit, remediation unit, thermal oxidizer, catalytic oxidizer or vapor incinerator process in which PM, air toxics, VOCs, landfill gas, digester gas or other combustible vapors are mixed in the unit's burner with combustion air or fuel, including but not limited to natural gas, propane, butane or LPG, prior to or at incineration in the unit, in order to maintain vapor concentration above the upper explosion limit or a manufacturer specified limit in order to maintain combustion or temperature in the unit
• Solid fuel-fired combustion equipment</td></tr>
<tr><td rowspan="3">Requirements (NOx Limits)</td><td colspan="4">Gaseous Fuel-Fired Equipment</td></tr>
<tr><td colspan="2">(ppmv corrected to 19% O2, dry unless otherwise specified)</td><td colspan="2">(ppmv corrected to 3% O2, dry unless otherwise specified)</td></tr>
<tr><td>Dehydrators</td><td>-</td><td>Oven, Dehydrator, Dryer, Heater, Kiln, Calciner, Cooker, Roaster, Furnace, or Heated Storage Tank</td><td><u><1,200°F</u>:
20-30 ppmv (0.024-0.036 lb/ MMBtu)

<u>≥1,200°F</u>:
30-60 ppmv (0.036-0.073 lb/ MMBtu)</td></tr>
</table>

	SJVAPCD Rule 4309		SCAQMD Rule 1147	
	Asphalt/Concrete Plants	4.3 ppmv (0.0492 lb/MMBtu)	See evaluation for SCAQMD Rule 1147.1 below.	
	Milk, Cheese and Dairy Processing (<20 MMBtu/hr)	3.5 ppmv (0.04 lb/MMBtu)	Equipment not listed, so it would be subject to emission limits of other processes (the last category listed below)	
	Milk, Cheese and Dairy Processing (≥20 MMBtu/hr)	5.3 ppmv (0.061 lb/MMBtu)		
	Other processes not described above	4.3 ppmv (0.0492 lb/MMBtu)	Afterburner, Degassing Unit, Thermal Oxidizer, Catalytic Oxidizer or Vapor Incinerator	20-60 ppmv (0.024-0.073 lb/MMBtu)
			Remediation Unit	60 ppmv (0.073 lb/MMBtu)
			Burn-off Furnace, Burnout Oven, Incinerator or Crematory with or without Integrated Afterburner	30-60 ppmv (0.036-0.073 lb/MMBtu)
			Evaporator, Fryer, Heated Process Tank, or Parts Washer	60 ppmv (0.073 lb/MMBtu)
			Make-Up Air Heater or other Air Heater located outside of building with temperature controlled zone inside building	30 ppmv (0.036 lb/MMBtu)
			Tenter Frame or Fabric or Carpet Dryer	20-30 ppmv (0.024-0.036 lb/MMBtu)
			Autoclave	30 ppmv (0.036 lb/MMBtu)
			Tunnel Kiln or Beehive Kiln	<1,200°F: 30 ppmv (0.036 lb/MMBtu) ≥1,200°F: 60 ppmv (0.073 lb/MMBtu)
			Chiller (Absorption or Adsorption)	20 ppmv (0.024 lb/MMBtu)
			Rotary Dryer	30 ppmv (0.036 lb/MMBtu)
			Other Unit or Process Temperature	<1,200°F: 30 ppmv (0.036 lb/MMBtu) ≥1,200°F: 60 ppmv (0.073 lb/MMBtu)
	Liquid Fuel-Fired Equipment			

	SJVAPCD Rule 4309		SCAQMD Rule 1147	
	All Liquid Fuel-Fired Units	Varies from 3.5-12 ppmv (0.04-0.14 lb/MMBtu)	All Liquid Fuel-Fired Units	<1,200°F: 40 ppmv (0.053 lb/MMBtu) ≥1,200°F: 60 ppmv (0.073 lb/MMBtu)

District Rule 4309 has previously been established as being at least as stringent as SCAQMD Rule 1147. The recently adopted SCAQMD Rule 1147 (Adopted May 6, 2022) maintained previous emission limits for existing units, which are consistent with the District's limits, and established lower limits for some categories of units that are phased in based on a unit's age. These newer limits are required after July 1, 2023 when a unit reaches up to 32 years of age, extending the compliance date for these limits to as late as June 30, 2055. Due to this extended compliance schedule, the new lower limits of SCAQMD Rule 1147 are not widely implemented and are well beyond BACM.

- SCAQMD Rule 1147.1 (NOx Reductions from Aggregate Dryers)

	SJVAPCD Rule 4309		SCAQMD Rule 1147.1	
Applicability	Any dryer, dehydrator, or oven that is fired on gaseous fuel, liquid fuel, or is fired on gaseous and liquid fuel sequentially, and the total rated heat input for the unit is ≥5 MMBtu/hr.		Owners or operators of gaseous fuel-fired aggregate dryers with NOx emissions ≥1 lb/day with rated heat input ≥2 MMBtu/hr.	
Requirements	Asphalt/Concrete Plants	4.3 ppmvd @ 19% O2	Aggregate Dryers	30-40 ppmvd @ 3% O2 (3.3-4.3 ppmvd @ 19% O2)

District Rule 4309 has previously been established as being at least as stringent as SCAQMD Rule 1147. The recently adopted SCAQMD Rule 1147.1 (Adopted August 6, 2021) established separate requirements for gaseous-fueled aggregate dryers previously subject to SCAQMD Rule 1147. Rule 1147.1 maintained the previous emission limit for existing units, which is consistent with the District's limit, and established a lower limit to be phased in based on burner age. This newer limit is required when a unit reaches up to 32 years of age. At this time, no units in SCAQMD have been required to meet this lower limit. Therefore, this limit is well beyond BACM.

Ventura County APCD

- VCAPCD Rule 74.34 (NOx Reductions from Miscellaneous Sources)

	SJVAPCD Rule 4309	VCAPCD Rule 74.34
Applicability	Dryer, dehydrator, or oven that is fired on gaseous fuel, liquid fuel, or is fired on gaseous and liquid fuel sequentially, and the total rated heat input for the unit is ≥5 MMBtu/hr.	Dryers, furnaces, heaters, incinerators, kilns, ovens, and duct burners. This rule applies to any unit where the total rated heat input for the unit is ≥5 MMBtu/hr.

<table>
<tr><th></th><th colspan="2">SJVAPCD Rule 4309</th><th colspan="2">VCAPCD Rule 74.34</th></tr>
<tr><td>Exemptions</td><td colspan="2">• Column-type or tower dryers used to dry grains, or tree nuts
• Units to pre-condition onions or garlic prior to dehydration
• Smokehouses or units used for roasting
• Units to bake or fry food for human consumption
• Charbroilers
• Units used to dry lint cotton or cotton at cotton gins
• Units with no stack for the exhaust gas and one or more sides open to the atmosphere
• Units subject to District Rules 4305, 4306, 4307, or 4351</td><td colspan="2">• Combustion equipment whose primary function is to operate as an air pollution control device
• Duct burners operating upstream of and controlled by a properly working SCR add-on NOx control unit
• Gas flares
• External combustion equipment subject to VCAPCD Rule 74.15 (Boilers, Steam Generators, and Process Heaters)</td></tr>
<tr><td rowspan="10">Requirements (NOx Limits)</td><td colspan="2">SJVAPCD Rule 4309
(ppmv corrected to 19% O2, dry unless otherwise specified)</td><td colspan="2">VCAPCD Rule 74.34
(ppmv corrected to 3% O2, dry unless otherwise specified)</td></tr>
<tr><td>Dehydrators</td><td>-</td><td colspan="2">Dehydrators not listed under applicability of the rule.</td></tr>
<tr><td>Asphalt/Concrete Plants</td><td>4.3 ppmv
(0.0492 lb/MMBtu)</td><td colspan="2">40 ppmv or 0.048 lb/MMBtu
(4.3 ppmvd @ 19% O2)</td></tr>
<tr><td>Milk, Cheese and Dairy Processing (<20 MMBtu/hr)</td><td>3.5 ppmv
(0.04 lb/MMBtu)</td><td colspan="2" rowspan="2">Equipment not listed, so it would be subject to emission limits of other processes (the last category listed below).</td></tr>
<tr><td>Milk, Cheese and Dairy Processing (≥20 MMBtu/hr)</td><td>5.3 ppmv
(0.061 lb/MMBtu)</td></tr>
<tr><td rowspan="5">Other processes not described above</td><td rowspan="5">4.3 ppmv
(0.0492 lb/MMBtu)</td><td>Sand and Gravel Processing (dryers)</td><td rowspan="2">40 ppmv or 0.048 lb/MMBtu
(4.3 ppmvd @ 19% O2)</td></tr>
<tr><td>Paper Products Manufacturing (Hot Air Furnace, Duct Burner, Paper Dryer)</td></tr>
<tr><td>Metal Heat Treatment/Metal Melting Furnace</td><td>60 ppmv or 0.072 lb/MMBtu
(6.5 ppmvd @ 19% O2)</td></tr>
<tr><td>Kiln</td><td>80 ppmv or 0.096 lb/MMBtu
(8.7 ppmvd @ 19% O2)</td></tr>
<tr><td>Oven, Dryer (besides asphalt, sand or paper dryer), Heater, Incinerator, Other Furnaces, or Other Duct Burner</td><td><1,200°F:
30 ppmv or 0.036 lb/MMBtu
(3.3 ppmvd @ 19% O2)

≥1,200°F:
60 ppmv or 0.072 lb/MMBtu
(6.5 ppmvd @ 19% O2)</td></tr>
</table>

VCAPCD Rule 74.34 establishes emission limits based on the process temperature whereas District Rule 4309 does not consider the process temperature and instead establishes emissions limits based on the equipment categories. Where the rules can be compared, the District rule is more stringent in several categories, such as metal heat treatment, metal melting furnace, kiln, etc. In other categories, the NOx limits under the VCAPCD rule vary from 3.3 to 6.5 ppmv at 19% O2 with an average of 4.9 ppmv, while District Rule 4309 limits NOx emissions from 3.5 to 5.3 ppmv with most categories limited to 4.3 ppmv at 19% O2, independent of the process temperature. Therefore, overall, District Rule 4309 is as stringent as or more stringent than VCAPCD Rule 74.34.

Potential Emission Reduction Opportunities

Beyond the review of current regulations and rule requirements, the District reviewed the feasibility of technologies and measures implemented in other regions and potential new technologies and measures that may be feasible for implementation in the near future. Based on this review, the District did not identify additional emission reduction opportunities for BACM at this time.

Evaluation Findings

Rule 4309 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.11 RULE 4311 (FLARES)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	0.17	0.17	0.17	0.13	0.13	0.13	0.13
NOx	0.52	0.51	0.50	0.30	0.30	0.30	0.30
	Winter Average - Tons per day						
PM2.5	0.17	0.17	0.17	0.13	0.13	0.13	0.13
NOx	0.52	0.51	0.50	0.30	0.30	0.30	0.30

District Rule 4311 Description

District Rule 4311 applies to any operation involving the use of a flare. This source category currently includes flares associated with oil and gas production, methane and VOC gases extracted from landfills, municipal sewage treatment, wastewater treatment at food production facilities, petroleum refining, and VOC control of blowing agents at plastics product manufacturing. Flaring is a high temperature oxidation process used to burn combustible components, mostly hydrocarbons, of waste gases from industrial operations. 95% of the waste gases flared are natural gas, propane, pentane, ethylene, propylene, butadiene, and butane. Rule 4311 contains operational requirements, flare minimization requirements for certain flares, and NOx and VOC emission limits for enclosed flares and any flare used over industry based thresholds.

Based on a comprehensive technical analysis, in-depth review of local, state, and federal regulations, and a robust public process, the District adopted amendments to Rule 4311 in December 2020 to reduce emissions from flaring in the Valley. These amendments removed the exemptions for flares operating at non-major source facilities as well as at landfills, and established low-NOx emissions limits for multiple categories of facilities with flares used over specified annual flaring throughput thresholds.

The District evaluated various approaches to determining thresholds to require flare operators to take action to reduce emissions. The only other rule in the nation requiring ultra-low NOx flares is South Coast Air Quality Management District (SCAQMD) Rule 1118.1. SCAQMD Rule 1118.1 sets thresholds for action based on a percentage of capacity used annually. Applying a percentage-based approach would have excluded some of the most highly used flares in the Valley. As an alternative to this approach, the District evaluated a set of annual throughput thresholds by flare type, with the goal of achieving emissions reductions in greater quantity and more cost effectively than those achievable under the approach included in SCAQMD Rule 1118.1. The approach included in the District’s amended rule is estimated to achieve a 37.2% reduction in NOx emissions and 19.4% reduction in PM2.5 emissions from flares. These emissions reductions are greater than reductions achieved by the approach included in SCAQMD Rule 1118.1 at approximately half the cost, by focusing on flares with the highest usage, resulting in a more effective rule.

The District adopted these amendments to reduce emissions from flaring in the Valley by requiring operators to install the cleanest ultra-low NOx flaring technology, and encouraging operators to seek beneficial uses for waste gas, rather than flaring in the most cost effective manner. The ultra-low NOx flaring technology represents the lowest emission flares available, and this requirement makes Rule 4311 the most stringent flare rule in the nation.

How does District Rule 4311 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Techniques Guidelines or Alternative Control Techniques applicable to this source category.

A. New Source Performance Standards (NSPS)

- *40 CFR 60.18 – General Control Device and Work Practice Requirements (2008/12)*
- *40 CFR 65.147 – Flares (2000/12)*
- *40 CFR 60 Subpart OOOOa – Standards of Performance for Crude Oil and Natural Gas Facilities for Which Construction, Modification, or Reconstruction Commenced After September 15, 2015 (2016/06)*
- *40 CFR 60 Subpart Ja – Standards of Performance for Petroleum Refineries for Which Construction, Reconstruction, or Modification Commenced After May 14, 2007 (2013/12)*

The District evaluated the requirements contained within the NSPS above, and found no requirements that were more stringent than those already in Rule 4311.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4311 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4311 to comparable requirements in rules from the following nonattainment areas:

- Bay Area AQMD Regulation 12, Rule 11 (Amended November 3, 2021)[93]

[93] BAAQMD. *Regulation 12, Rule 11 (Flare Monitoring at Refineries).* (Amended November 3, 2021). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/refinery-rules-definitions/rg1211_20211103-pdf.pdf?la=en&rev=694ca947de004a788d889ad213e7955b

- Bay Area AQMD Regulation 12, Rule 12 (Amended November 3, 2021)[94]
- San Diego County APCD Rule 69.7 (Adopted March 9, 2023)[95]
- Santa Barbara County APCD Rule 359 (Amended June 28, 1994)[96]
- South Coast AQMD Rule 1118 (Amended January 6, 2023)[97]
- South Coast AQMD Rule 1118.1 (Adopted January 4, 2019)[98]

Sacramento Metropolitan AQMD and Ventura County APCD do not have an analogous rule for this source category.

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4311 continues to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rules is demonstrated below.

Bay Area AQMD

- BAAQMD Regulation 12, Rule 11 (Flare Monitoring at Refineries)
- BAAQMD Regulation 12, Rule 12 (Flares at Refineries)

The District's Rule 4311 includes requirements that correspond to both BAAQMD Regulation 12 Rules 11 and 12. Therefore, the following table compares District Rule 4311 to the requirements from both BAAQMD rules.

	SJVAPCD Rule 4311	BAAQMD Reg 12, Rule 11 BAAQMD Reg 12, Rule 12
Applicability	All flares.	Flares used at refineries.

Exemptions	• Flares operated at municipal solid waste landfills that combust <2,000 MMscf of landfill gas per calendar year and that have ceased accepting waste
	• Flares that combust only propane, butane, or a combination of propane and butane
	• Flares used for well testing, tank degassing, and pipeline degassing operations
	• Flares that combust regeneration gas
		• Flares and thermal oxidizers used for:
		  ○ Emissions from organic liquid storage vessels (subj. to R. 8-5)
		  ○ Emissions from loading racks (subj. to R. 8-6, 8-33, or 8-39)
		  ○ Emissions from marine vessel loading terminals (subj. to R. 8-44)
		• Thermal oxidizers used for:
		  ○ Emissions from wastewater treatment systems (subj. to R. 8-8)
		  ○ Emissions from pump seals (subj. to R. 8-18) (except when emissions from pump are routed to flare header)

94 BAAQMD. *Regulation 12, Rule 12 (Flares at Refineries).* (Amended November 3, 2021). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/refinery-rules-definitions/rg1212_20211103-pdf.pdf?la=en&rev=7db93f23469747fc8eca3b3f2dc773ff
95 SDAPCD. *Rule 69.7 (Landfill Gas Flares).* (Adopted March 9, 2023). Retrieved from: https://www.sdapcd.org/content/dam/sdapcd/documents/rules/current-rules/Rule-69.7.pdf
96 SBCAPCD. *Rule 359 (Flares and Thermal Oxidizers).* (Adopted June 28, 1994). Retrieved from: https://ww2.arb.ca.gov/sites/default/files/classic/technology-clearinghouse/rules/RuleID2475.pdf
97 SCAQMD. *Rule 1118 (Control of Emissions from Refinery Flares).* (Amended January 6, 2023). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1118.pdf?sfvrsn=4
98 SCAQMD. *Rule 1118.1 (Control of Emissions from Non-Refinery Flares).* (Adopted January 4, 2019). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/R1118-1.pdf?sfvrsn=9

	SJVAPCD Rule 4311	BAAQMD Reg 12, Rule 11 BAAQMD Reg 12, Rule 12
		Reg 12, Rule 11 Only: • Monitoring and reporting total HC or methane composition doesn't apply to flare that burns flexicoker gas if weekly sampling shows methane/non-methane content of vent gas flared is <2%/<1% by volume.
Requirements	Requires flare operators to limit flare operation not to exceed flare throughput threshold based on vocation for 2 consecutive years or meet NOx limits: • Flares used at oil and gas operations, and chemical operations: 25,000 MMBtu/yr or 0.005 lb-VOC/MMBtu, 0.018 lb-NOx/MMBtu; • Flares at landfill operations: 90,000 MMBtu/yr or 0.038 lb-VOC/MMBtu and 0.025 lb-NOx/MMBtu; • Flares at digester operations at a major source facility: 100,000 MMBtu/yr or 0.038 lb-VOC/MMBtu and 0.025 lb-NOx/MMBtu; • Flares at digester operations not at a major source facility: 100,000 MMBtu/yr or 0.060 lb-NOx/MMBtu; • Flares at organic liquid loading operations: 25,000 MMBtu/yr or 0.034 lb-NOx/MMBtu. Recordkeeping and reporting. Flare minimization plan for refinery flares or flares ≥5 MMBtu/hr at major sources of NOx or VOC, except landfill operations.	No emission limit requirements.

The District evaluated the requirements contained within BAAQMD's Regulation 12, Rules 11 and 12 and found no requirements that were more stringent than those in Rule 4311. Therefore, District Rule 4311 is as stringent as or more stringent than BAAQMD Regulation 12, Rule 11 and 12.

San Diego County APCD

- SDAPCD Rule 69.7 (Landfill Gas Flares)

	SJVAPCD Rule 4311	SDAPCD Rule 69.7
Applicability	All flares.	Landfill gas flares at a municipal solid waste landfill where emissions from such flares are at or above the federal major source threshold for NOx.
Exemptions	• Flares operated at municipal solid waste landfills that combust <2,000 MMscf of landfill gas per calendar year and that have ceased accepting waste	• Existing open landfill gas flares are exempt from standards, test methods, and source test requirements of rule

	SJVAPCD Rule 4311	SDAPCD Rule 69.7
	• Flares that combust only propane, butane, or a combination of propane and butane • Flares used for well testing, tank degassing, and pipeline degassing operations • Flares that combust regeneration gas	
Requirements	Requires flare operators to limit flare operation not to exceed flare throughput threshold based on vocation for 2 consecutive years or meet NOx limits: • Flares used at oil and gas operations, and chemical operations: 25,000 MMBtu/yr or 0.005 lb-VOC/MMBtu, 0.018 lb-NOx/MMBtu; • Flares at landfill operations: 90,000 MMBtu/yr or 0.038 lb-VOC/MMBtu and 0.025 lb-NOx/MMBtu; • Flares at digester operations at a major source facility: 100,000 MMBtu/yr or 0.038 lb-VOC/MMBtu and 0.025 lb-NOx/MMBtu; • Flares at digester operations not at a major source facility: 100,000 MMBtu/yr or 0.060 lb-NOx/MMBtu; • Flares at organic liquid loading operations: 25,000 MMBtu/yr or 0.034 lb-NOx/MMBtu. Recordkeeping and reporting. Flare minimization plan for refinery flares or flares ≥5 MMBtu/hr at major sources of NOx or VOC, except landfill operations.	A person shall not install and/or operate an enclosed landfill gas flare unless NOx emissions do not exceed 0.06 lbs/MMBtu. Operational, monitoring, recordkeeping, testing requirements.

The District evaluated the requirements contained within SDAPCD's Rule 69.7 and found no requirements that were more stringent than those in Rule 4311. In fact, District Rule 4311 includes requirements for flares in other facility types beyond municipal solid waste. Therefore, District Rule 4311 is as stringent as or more stringent than SDAPCD Rule 69.7.

South Coast AQMD

- SCAQMD Rule 1118 (Control of Emissions from Refinery Flares)

	SJVAPCD Rule 4311	SCAQMD Rule 1118
Applicability	All flares.	Flares used at petroleum refineries, sulfur recovery plants, and hydrogen production plants.
Exemptions	• Flares operated at municipal solid waste landfills that combust <2,000 MMscf of landfill gas per calendar year and that have ceased accepting waste	• Exempt from sampling and analyses for higher heating values and sulfur concentration for flare event that: ○ Results from catastrophic event

	SJVAPCD Rule 4311	SCAQMD Rule 1118
	• Flares that combust only propane, butane, or a combination of propane and butane • Flares used for well testing, tank degassing, and pipeline degassing operations • Flares that combust regeneration gas	○ Is safety hazard to sampling personnel • SOx from flaring events caused by: ○ External power curtailment beyond operator's control ○ Natural disasters ○ Acts of war or terrorism (Not exempt from flare monitoring system requirements)
Requirements	Limit flare operation not to exceed a flare throughput threshold based on vocation for two consecutive years or meet NOx limits: • Flares used at oil and gas operations, and chemical operations: 25,000 MMBtu/yr or 0.005 lb-VOC/MMBtu, 0.018 lb-NOx/MMBtu; • Flares at landfill operations: 90,000 MMBtu/yr or 0.038 lb-VOC/MMBtu and 0.025 lb-NOx/MMBtu; • Flares at digester operations at a major source facility: 100,000 MMBtu/yr or 0.038 lb-VOC/MMBtu and 0.025 lb-NOx/MMBtu; • Flares at digester operations not at a major source facility: 100,000 MMBtu/yr or 0.060 lb-NOx/MMBtu; • Flares at organic liquid loading operations: 25,000 MMBtu/yr or 0.034 lb-NOx/MMBtu. Recordkeeping and reporting. Flare minimization plan for refinery flares or flares ≥5 MMBtu/hr at major sources of NOx or VOC, except landfill operations.	No emission limit requirements.

The District evaluated the requirements contained within SCAQMD's Rule 1118 and found no requirements that were more stringent than those in Rule 4311. Therefore, District Rule 4311 is as stringent as or more stringent than SCAQMD Rule 1118.

South Coast AQMD

- SCAQMD Rule 1118.1 (Control of Emissions from Non-Refinery Flares)

	SJVAPCD Rule 4311	SCAQMD Rule 1118.1
Applicability	All flares.	Flares that require a SCAQMD permit used at non-refinery facilities, including, but not limited to oil and gas production facilities, wastewater treatment facilities, landfills, and organic liquid handling facilities.

	SJVAPCD Rule 4311	SCAQMD Rule 1118.1
Exemptions	• Flares operated at municipal solid waste landfills that combust <2,000 MMscf of landfill gas per calendar year and that have ceased accepting waste • Flares that combust only propane, butane, or a combination of propane and butane • Flares used for well testing, tank degassing, and pipeline degassing operations • Flares that combust regeneration gas	• Flares at asphalt plants, biodiesel plants, hydrogen production plants fueled in part with refinery gas, petroleum refineries, sulfuric acid plants, and sulfur recovery plants • Flares routing only natural gas to the burner that are subject to SCAQMD Misc. Source NOx rule • Flares combusting only propane, butane, or a combination of propane and butane • Flares at closed landfills collecting <2,000 MMscf of landfill gas per calendar year • Flares with a various location permit • Flares combusting regeneration gas • Flares emitting <30 lb-NOx/month • Flares with an annual throughput limit equivalent to 200 hr/year • Gas combusted during a utility pipeline curtailment is not used to calculate exceedance of use requirements
Requirements	Requires flare operators to limit flare operation not to exceed flare throughput threshold based on vocation for 2 consecutive years or meet NOx limits: • Flares used at oil and gas operations, and chemical operations: 25,000 MMBtu/yr or 0.005 lb-VOC/MMBtu, 0.018 lb-NOx/MMBtu; • Flares at landfill operations: 90,000 MMBtu/yr or 0.038 lb-VOC/MMBtu and 0.025 lb-NOx/MMBtu; • Flares at digester operations at a major source facility: 100,000 MMBtu/yr or 0.038 lb-VOC/MMBtu and 0.025 lb-NOx/MMBtu; • Flares at digester operations not at a major source facility: 100,000 MMBtu/yr or 0.060 lb-NOx/MMBtu; • Flares at organic liquid loading operations: 25,000 MMBtu/yr or 0.034 lb-NOx/MMBtu. Recordkeeping and reporting. Flare minimization plan for refinery flares or flares ≥5 MMBtu/hr at major sources of NOx or VOC, except landfill operations.	Throughput limits for new or replacement flares of 110% of replaced flare or 45 MMscf/year. New flare emission limits based on type of gas flared: • Produced gas: 0.018 lb-NOx/MMBtu, 0.01 lb-CO/MMBtu, 0.008 lb-VOC/MMBtu; • Landfill gas, and digester gas at a major facility: 0.025 lb-NOx/MMBtu, 0.06 lb-CO/MMBtu, 0.038 lb-VOC/MMBtu; • Digester gas at a minor facility, and other flare gas: 0.06 lb-NOx/MMBtu; • Organic liquid storage: 0.25 lb-NOx/MMBtu, 0.37 lb-CO/MMbtu; • Organic liquid loading: 0.034 lb-NOx/1,000 gallons loaded, 0.05 lb-CO/1,000 gallons loaded. Establishes requirements for existing flares not meeting the above emission limits based on exceeding a vocation based fractional use of total capacity in two consecutive calendar quarters. Fraction limits are: 5% for produced gas or any open flare; 70% for digester gas; and 20% for landfill gas. Units exceeding these limits must reduce flaring or replace with a new flare meeting emission limit requirements.

The District evaluated the requirements contained within SCAQMD's Rule 1118.1 and found no requirements that were more stringent than those in Rule 4311. Therefore, District Rule 4311 is as stringent as or more stringent than SCAQMD Rule 1118.1.

Potential Emission Reduction Opportunities

Beyond the review of current regulations and rule requirements, the District reviewed the feasibility of technologies and measures implemented in other regions and potential new technologies and measures that may be feasible for implementation in the near future. However, the District did not identify additional emission reduction opportunities at this time.

Evaluation Findings

Rule 4311 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.12 RULE 4313 (LIME KILNS)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day						
PM2.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00

The emissions inventory for the lime kiln source category is 0.00 tpd because there are no lime kilns in operation in the Valley.

District Rule 4313 Description

District Rule 4313 was adopted in 2003 to limit NOx emissions from the operation of lime kilns. Lime kilns can be used in a variety of manufacturing and processing operations, including food and agriculture. At the time of rule adoption, there were a total of three lime kilns in operation in the Valley. These lime kilns were operated at two sugar processing plants; however, these plants have been non-operational since 2008. There are currently no lime kilns operating in the Valley. If any lime kilns were to begin operation in the Valley in the future they would be required to meet District BACT requirements, per District Rule 2201 (New and Modified Stationary Source Review Rule). There are no lime kilns currently going through the District's permitting process to become operational in the Valley, and the District does not expect any lime kilns to operate in the Valley in the future.

How does District Rule 4313 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Technique Guidelines or Alternative Control Techniques applicable to this source category.

A. New Source Performance Standards (NSPS)

- *40 CFR 60 Subpart HH – Standards of Performance for Lime Manufacturing Plants (1984/04)*

The District evaluated the requirements contained within 40 CFR 60 Subpart HH and found no requirements that were more stringent than those already in Rule 4313.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4313 compare to rules in other air districts?

Bay Area AQMD, Sacramento Metropolitan AQMD, South Coast AQMD, and Ventura County APCD do not have analogous rules for this source category.

Potential Emission Reduction Opportunities

There are currently no lime kilns in operation in the Valley. Therefore, the District did not identify any additional emission reduction opportunities at this time.

Evaluation Findings

There are no lime kilns in operation in the Valley, nor are any expected to be operated in the Valley in the future. However, if any lime kilns were to begin operating in the Valley, it would be required to meet District BACT requirements. As such, Rule 4313 meets or exceeds federal BACM requirements for this source category.

2.13 RULE 4352 (SOLID FUEL FIRED BOILERS, STEAM GENERATORS, AND PROCESS HEATERS)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	0.18	0.18	0.18	0.13	0.13	0.14	0.14
NOx	1.87	1.86	1.88	1.53	1.54	1.64	1.65
	Winter Average - Tons per day						
PM2.5	0.18	0.18	0.18	0.13	0.13	0.14	0.14
NOx	1.87	1.86	1.88	1.53	1.54	1.64	1.64

District Rule 4352 Description

The purpose of Rule 4352 is to limit NOx, CO, PM10, and SOx emissions from any boiler, steam generator or process heater fired on solid fuel. Operations use these units in a broad range of industrial, commercial, and institutional settings. These units have the ability to fire on a variety of solid fuels, including coal, petroleum coke, biomass, tire-derived fuel, and municipal solid waste (MSW). The District currently permits ten biomass fired units in the Valley; however, only five biomass fired units are currently operating. All five operating units generate electricity for electric utilities. The remaining five units are closed and dormant. Two solid fuel fired units permitted within the District use MSW as their energy source. The MSW fired units are located at a single facility that generates electricity for electric utilities.

The adoption of Rule 4352 on September 14, 1994, established NOx limits of 200 ppmv for MSW facilities, 0.35 lb/MMBtu for biomass facilities, and 0.20 lb/MMBtu for all other solid fuel fired units. The District has amended this rule four times since adoption.

The District Governing Board adopted the most recent amendments to Rule 4352 on December 16, 2021. Based on a comprehensive technical analysis, in-depth review of local, state, and federal regulations, and a robust public process, the District adopted several modifications to Rule 4352 to include even more stringent NOx limits, and to establish PM10 and SOx emission limits for applicable units operating in the Valley. The amendments to Rule 4352 also added language to clarify definitions, remove expired language, and establish compliance timelines.

Table 2-3 Rule 4352 NOx, CO, PM10, and SOx Emission Limits

<table>
<tr><th rowspan="2">Fuel Type</th><th colspan="4">Emission Limits effective on and after January 1, 2024</th></tr>
<tr><th>NOx</th><th>CO</th><th>PM10</th><th>SOx</th></tr>
<tr><td>MSW</td><td>110 ppmv corrected to 12% CO2 [A]

90 ppmv corrected to 12% CO2 [C]</td><td rowspan="3">400 ppmv corrected to 3% O2 [A]</td><td>0.04 lbs/MMBtu
or
0.02 gr/dscf @ 12% CO2</td><td>0.03 lbs/MMBtu [C]
or
12 ppmv @ 12% CO2 [C]

0.064 lbs/MMBtu [A]
or
25 ppmv @ 12% CO2 [A]</td></tr>
<tr><td>Biomass</td><td>65 ppmv corrected to 3% O2 [A]</td><td>0.03 lbs/MMBtu</td><td>0.02 lbs/MMBtu [B]
0.035 lbs/MMBtu [A]</td></tr>
<tr><td>All Others</td><td>65 ppmv corrected to 3% O2 [A]</td><td>0.03 lbs/MMBtu</td><td>0.02 lbs/MMBtu [B]
0.035 lbs/MMBtu [A]</td></tr>
</table>

[A] Block 24-hour average
[B] Rolling 30-day average
[C] Rolling 12-month average

How does District Rule 4352 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Techniques Guidelines applicable to this source category.

A. Alternative Control Techniques (ACT)

- *Alternative Control Techniques Document – NOx Emissions from Industrial, Commercial, and Institutional Boilers (EPA-453/R-94-022 1994/03)*
- *Alternative Control Techniques Document – NOx Emissions from Utility Boilers (EPA-453/R-94-023 1994/03)*

The District evaluated the requirements contained within the ACT for NOx Emissions from Industrial/Commercial/Institutional Boilers and the ACT for NOx Emissions from Utility Boilers and found no requirements that were more stringent than those already in Rule 4352.

B. New Source Performance Standards (NSPS)

- *40 CFR 60 Subpart Cb – Emission Guidelines and Compliance Times for Large Municipal Waste Combustors that are Constructed On or Before September 20, 1994 (1995/12)*

The District evaluated the requirements contained within 40 CFR 60 Subpart Cb and found no requirements that were more stringent than those already in Rule 4352.

- *40 CFR 60 Subpart D – Standards of Performance for Fossil-Fuel-Fired Steam Generators (2007/06)*

The District evaluated the requirements contained within 40 CFR 60 Subpart D and found no requirements that were more stringent than those already in Rule 4352.

- *40 CFR 60 Subpart Da – Standards of Performance for Electric Utility Steam Generating Units (2013/04)*
- *40 CFR 60 Subpart Db – Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units (2007/06)*
- *40 CFR 60 Subpart Dc – Standards of Performance for Industrial-Commercial-Institutional Steam Generating Units (2014/02)*

The District evaluated the requirements contained within the 40 CFR 60 Subpart Da, Db and Dc and found no requirements that were more stringent than those already in Rule 4352.

- *40 CFR 60 Subpart Ea – Standards of Performance for Municipal Waste Combustors for Which Construction is Commenced After December 20, 1989 and On or Before September 20, 1994 (1995/12)*
- *40 CFR 60 Subpart Eb – Standards of Performance for Municipal Waste Combustors for Which Construction is Commenced After September 20, 1994 or for Which Modification or Reconstruction is Commenced After June 19, 1996 (2007/03)*

The District evaluated the requirements contained within 40 CFR 60 Subparts Ea and Eb and found no requirements that were more stringent than those already in Rule 4352.

- *40 CFR 60 Subpart AAAA – Standards of Performance for Small Municipal Waste Combustion Units for Which Construction is Commenced After August 30, 1999 or for Which Modification is Commenced After June 6, 2001 (2003/01)*
- *40 CFR 60 Subpart BBBB – Standards of Performance for Small Municipal Waste Combustion Units Constructed On or Before August 30, 1999 (2003/01)*

The District evaluated the requirements contained within 40 CFR 60 Subparts AAAA and BBBB and found no requirements that were more stringent than those already in Rule 4352.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4352 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4352 to comparable requirements in rules from the following:

- Bay Area AQMD Regulation 9, Rule 7 (Amended May 4, 2011)[99]
- Bay Area AQMD Regulation 9, Rule 11 (Adopted May 17, 2000)[100]
- El Dorado County AQMD Rule 232 (Amended September 25, 2001)[101]
- Placer County APCD Rule 233 (Amended June 14, 2012)[102]
- Sacramento Metropolitan AQMD Rule 411 (Amended August 23, 2007)[103]
- South Coast AQMD Rule 1146 (Amended December 7, 2018)[104]
- Yolo-Solano AQMD Rule 2-43 (Amended November 10, 2010)[105]

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4352 continues to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rules is demonstrated below.

South Coast AQMD

- SCAQMD Rule 1146 (Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters)

	SJVAPCD Rule 4352	SCAQMD Rule 1146
Applicability	Any boiler, steam generator, or process heater fired on solid fuel.	Boilers, steam generators, and process heaters ≥5 MMBtu/hr rated heat input capacity used in all industrial, institutional, and commercial operations and fired on fossil fuels.
Exemptions	None	• Units with rated heat input capacity ≤5 MMBtu/hr • Units used exclusively to produce electricity
Requirements	**NOx emission limits** *Effective on and after Jan. 1, 2024* MSW 110 ppmv corrected to 12% CO2[A] 90 ppmv corrected to 12% CO2[C]	No applicable limits for units similar to those in the San Joaquin Valley.

[99] BAAQMD. *Regulation 9, Rule 7 (Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters).* (Amended May 4, 2011). Retrieved from: https://www.baaqmd.gov/rules-and-compliance/rules/reg-9-rule-7-nitrogen-oxides-and-carbon-monoxide-from-industrial-institutional-and-commercial-boiler

[100] BAAQMD. *Regulation 9, Rule 11 (Nitrogen Oxides and Carbon Monoxide from Utility Electric Power Generating Boilers).* (Adopted May 17, 2000). Retrieved from: https://www.baaqmd.gov/rules-and-compliance/rules/reg-9-rule-11-nitrogen-oxides-and-carbon-monoxide-from-utility-electric-power-generating-boilers

[101] EDCAQMD. *Rule 232 (Biomass Boilers).* (Amended September 25, 2001). Retrieved from: https://ww2.arb.ca.gov/sites/default/files/classic/technology-clearinghouse/rules/RuleID819.pdf

[102] PCAPCD. *Rule 233 (Biomass Boilers).* (Amended June 14, 2012). Retrieved from: https://www.placerair.org/DocumentCenter/View/2205/Rule-233-PDF

[103] SMAQMD. *Rule 411 (NOx from Boilers, Process Heaters and Steam Generators)*. (Amended August 23, 2007). Retrieved from: http://www.airquality.org/ProgramCoordination/Documents/rule411.pdf

[104] SCAQMD. *Rule 1146 (Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters).* (Amended December 7, 2018). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1146.pdf

[105] YSAQMD. *Rule 2-43 (Biomass Boilers).* (Amended November 10, 2010). Retrieved from: https://www.ysaqmd.org/wp-content/uploads/2020/05/2.43.pdf

	SJVAPCD Rule 4352	SCAQMD Rule 1146
	Biomass 65 ppmv NOx corrected to 3% O_2 [A] All others 65 ppmv NOx corrected to 3% O_2 [A] [A] Block 24-hour average [B] Rolling 30-day average [C] Rolling 12-month average **PM10 Emission Limits** *Effective on and after Jan. 1, 2024* MSW 0.04 lbs/MMBtu or 0.02 gr/dscf @ 12% CO_2 Biomass 0.03 lbs/MMBtu All others 0.03 lbs/MMBtu	

SCAQMD Rule 1146 specifically exempts units that are used exclusively to produce electricity for sale. Therefore, this rule cannot be compared to District Rule 4352.

Potential Emission Reduction Opportunities

On December 16, 2021 the District Governing Board adopted amendments to Rule 4352 that included even more stringent NOx emission limits for solid fuel fired boilers, steam generators, and process heaters operating in the Valley. As part of the rule development, the District conducted an incremental cost effectiveness analysis. The incremental cost effectiveness is the difference in cost between successively more effective controls divided by the additional emission reductions achieved.

The District evaluated several technology options to lower the NOx emissions at the municipal solid waste facility in the District. The new NOx limit of 90 ppm requires the installation of Covanta LN technology. Other more stringent control options evaluated included SCR, Gore De-NOx, Covanta LN with SCR, and Covanta LN with Gore De-NOx.

The District also evaluated several technology options to lower the NOx emissions for biomass fueled units. The new limit requires the establishment of a 65 ppm NOx limit. Other more stringent control options evaluated included SCR, Gore De-NOx, new boilers with SCR, and new boilers with Gore De-NOx.

The incremental cost effectiveness analysis did not demonstrate that any of the alternative control technologies were cost effective. Facilities are still in the process of complying with the most recent amendments by January 1, 2024. Therefore, the District did not identify additional emission reduction opportunities at this time.

Evaluation Findings

Rule 4352 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.14 RULE 4354 (GLASS MELTING FURNACES)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	0.27	0.27	0.28	0.18	0.18	0.19	0.19
NOx	3.37	3.42	3.65	3.08	3.08	2.05	2.05
	Winter Average - Tons per day						
PM2.5	0.27	0.27	0.28	0.18	0.18	0.19	0.19
NOx	3.37	3.42	3.64	3.07	3.08	2.05	2.05

District Rule 4354 Description

The provisions of Rule 4354 are applicable to glass melting furnaces in the Valley. The purpose of this rule is to limit NOx, SOx, VOC, CO, and PM10 emissions from glass melting furnaces.

The District adopted Rule 4354 on September 14, 1994, and subsequently amended the rule seven times. The District most recently adopted amendments to Rule 4354 on December 16, 2021. These amendments implement even more stringent NOx, SOx, and PM emissions limits for glass melting furnaces, including NOx limits as low as 0.75 pounds of NOx per ton of glass pulled, establishing requirements that are more stringent than any other rule in non-attainment areas in California and the nation. Due to the high costs associated with the control technology necessary to comply with the proposed final NOx emissions limits, a phased compliance schedule was adopted in which operators must comply with Phase I NOx emissions limits by 2024, and then with final NOx emissions limits by 2030 or upon the completion of the next furnace rebuild, whichever is sooner.

How does District Rule 4354 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Techniques Guidelines applicable to this source category.

A. Alternative Control Techniques (ACT)

- *Alternative Control Techniques Document – NOx Emissions from Glass Manufacturing (EPA-453/R-94-37 1994/06)*

The District evaluated the requirements contained within the ACT for NOx Emissions from glass melting furnaces and found no requirements that were more stringent than those already required by Rule 4354.

B. New Source Performance Standards (NSPS)

- *40 CFR 60 Subpart CC – Standards of Performance for Glass Manufacturing Plants (2000/10)*

The District evaluated the requirements contained within 40 CFR 60 Subpart CC and found that none of the glass plants located within the Valley are subject to its requirements.

- *40 CFR 60 Subpart PPP – Standards of Performance for Wool Fiberglass Manufacturing Plants (2000/10)*

The District evaluated the requirements contained within Subpart PPP and found no requirements that were more stringent than those already in Rule 4354.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4354 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4354 to comparable requirements in rules from the following California nonattainment areas:

- Bay Area AQMD Regulation 9, Rule 12 (Adopted January 19, 1994)[106]
- South Coast AQMD Rule 1117 (Amended June 5, 2020)[107]

Sacramento Metropolitan AQMD and Ventura County APCD do not have an analogous rule for this source category.

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4354 continues to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rule is demonstrated below.

[106] BAAQMD. *Regulation 9, Rule 12 (Nitrogen Oxides from Glass Melting Furnaces).* (Adopted January 19, 1994). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-12-nitrogen-oxides-from-glass-melting-furnaces/documents/rg0912.pdf?la=en&rev=29e7064c0e39439c9dee09b104af8dff
[107] SCAQMD. *Rule 1117 (Emissions from Container Glass Melting and Sodium Silicate Furnaces).* (Amended June 5, 2020). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1117.pdf?sfvrsn=4

South Coast AQMD

- SCAQMD Rule 1117 (Emissions of Oxides of Nitrogen from Container Glass Melting and Sodium Silicate Furnaces)

	SJVAPCD Rule 4354		SCAQMD Rule 1117
Applicability	Any glass melting furnace for the production of, container glass, fiberglass, and flat glass.		This rule limits the emission of NOx from facilities producing container glass and sodium silicate.
Exemption	• Furnaces which heat is provided by electric current from electrodes		• Furnaces which are limited by permit to 100 tons of product pulled per calendar year • Glass remelt facilities using exclusively glass cullet, marbles, chips, or similar feedstock in lieu of basic glass-making raw materials • Furnaces used in the melting of glass for the production of fiberglass exclusively
Requirements	**Container Glass:**		
	NOx Phase I (by no later than 12/31/2023)	1.1 lb/ton[B]	0.75 lb/ton[B]
	NOx Phase II (by no later than 12/31/2029)	0.75 lb/ton[B]	
	PM10 (Until 12/31/2023)	0.50 lb/ton[A]	No Limit Specified
	PM10 (On and after 1/1/2024)	0.20 lb/ton[A]	
	Fiberglass:		
	NOx	1.3 lb/ton[A, C]	No Limit Specified, Exempt from Rule
		3.0 lb/ton[A, D]	
	PM10	0.50 lb/ton[A]	No Limit Specified, Exempt from Rule
	Flat Glass:		
	NOx Phase I (by no later than 12/31/2023)	2.8 lb/ton[A]	No Limits Specified, Outside of Rule Applicability
		2.5 lb/ton[B]	
	NOx Phase II (by no later than 12/31/2029)	1.7 lb/ton[A]	
		1.5 lb/ton[B]	
	PM10 (Until 12/31/2023)	0.70 lb/ton[A]	No Limits Specified, Outside of Rule Applicability
	PM10 (On and after 1/1/2024)	0.20 lb/ton[A]	

[A] Block 24-hour average
[B] Rolling 30-day average
[C] Not subject to California Public Resources Code Section 19511
[D] Subject to California Public Resources Code Section 19511

The District evaluated the control requirements in SCAQMD Rule 1117, and found that District Rule 4354 is as stringent as or more stringent than SCAQMD Rule 1117.

Potential Emission Reduction Opportunities

Beyond the review of current regulations and rule requirements, the District performed an extensive review of the feasibility of technologies and measures implemented in other regions and potential new technologies and measures that may be feasible for implementation in the near future.

Electric Glass Melting Furnaces
The District considered the feasibility of using electric furnaces to reduce emissions. One of the container glass manufacturing facilities in the Valley is permitted to operate an electric glass melting furnace. However, this electric furnace has been out of glass production operation for more than ten years. During staff research, the District concluded that electric furnaces require a limited pull rate, and have a production capacity limited to a maximum of about 300 tons of glass per day. Furthermore, the District determined that electric furnace technology is only compatible with container glass manufacturing, and not compatible for flat glass production due to the technological design of electric furnaces and the need for a substantial float to provide heat insulation. The District did not identify any electric furnaces operating as the primary glass melting unit for flat glass manufacturing facilities. For container glass operations, multiple electric furnaces would need to be purchased to replace one existing natural-gas fired furnace, and operators would incur significant additional O&M costs, as compared to the operation of a furnace fired on natural gas. The typical electric furnace life is 4 years, compared to 10-12 years of that of a natural gas furnace with electric boost, further increasing the costs associated with operating an electric furnace in lieu of a natural gas-fired furnace.

Furthermore, electric furnaces consume more total energy per ton of glass, and would require much higher electricity capacity than is currently available from the electrical grid. For example, a modern 230 ton per day electric furnace has an electricity consumption rating of approximately 7.5 megawatts (MW), compared to a 430 ton per day natural gas furnace with electric boost where the maximum energy consumption is about 2.6 MW. More than 10 MW of additional electrical capacity at a glass production plant would be required to replace just one 430 ton per day furnace. The associated draw on the electrical grid to support required glass production levels for plants operating in the Valley would not be feasible or supported through the current electrical infrastructure or capacity in the region. While electric furnaces may be used for small production operations, or to provide additional heating boosts as an auxiliary unit at large manufacturing plants, the District determined that the use of electric furnaces as the primary glass melting furnace for large production operations is not currently feasible or cost effective due to the above considerations.

Based on this exhaustive review, the District did not identify additional emission reduction opportunities at this time.

Evaluation Findings

Rule 4354 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.15 RULE 4550 (CONSERVATION MANAGEMENT PRACTICES)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	18.46	18.33	18.15	17.99	17.84	17.75	17.70
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day						
PM2.5	12.06	11.95	11.80	11.66	11.55	11.47	11.44
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00

District Rule 4550 Description

Rule 4550 was adopted on August 19, 2004, to help bring the Valley into attainment of federal PM10 standards, and applies to on-field farming and agricultural operation sites located within the Valley. Rule 4550 was the first rule of its kind in the nation to target fugitive particulate emissions from agricultural operations, and it has served as a model for other regions. The District worked extensively with numerous stakeholders, growers, and the Agricultural Technical Committee for the San Joaquin Valleywide Air Pollution Study Agency (AgTech) for two years prior to developing the Conservation Management Practices (CMP) Rule. The District also worked with agricultural stakeholders and other agencies, such as the Natural Resources Conservation Service (NRCS), following rule adoption to ensure affected sources were assisted as much as possible in understanding and complying with the requirements of Rule 4550. Implementation of Rule 4550 by agricultural operations has resulted in the reduction of PM2.5 emissions through the reduction of passes of agricultural equipment and implementation of other conservation practices. Through this rule, PM10 emissions have been reduced by 35.3 tons per day. Rule 4550 has since served as a model for other regions seeking to reduce fugitive PM10 emissions from agricultural sources.

EPA finalized approval of Rule 4550 on February 14, 2006 and determined that the rule met BACM requirements.[108] Subsequent to EPA's approval of Rule 4550, two separate lawsuits were filed challenging EPA's approval of the rule as satisfying BACM. The Ninth District Court of Appeals, in both cases, agreed with EPA's approval and reaffirmed EPA's finding that the District's Rule 4550 meets BACM requirements.[109,110]

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108 71 FR 7683-7688. *Revisions to the California State Implementation Plan; San Joaquin Valley Unified Air Pollution Control District.* (February 14, 2006). Retrieved from: http://www.gpo.gov/fdsys/pkg/FR-2006-02-14/pdf/06-1311.pdf

109 U.S. Court of Appeals for the Ninth Circuit. *Latino Issues Forum v. EPA.* Retrieved from: http://njlaw.rutgers.edu/collections/resource.org/fed_reporter/NEWcircs/cir9/0671907_cir9.html

110 SJVAPCD. *Court rules in favor of Air District ag rule.* (March 6, 2009). Retrieved from: https://www.valleyair.org/recent_news/Media_releases/2009/PR%20Court%20decision%20favors%20District%20ag%20rule.pdf

In an effort to further reduce emissions from this source category, the District's *2018 PM2.5 Plan* included a commitment to evaluate the feasibility and effectiveness of CMPs on fallow lands that are tilled or otherwise worked with implements of husbandry to reduce windblown PM2.5 emissions from disturbed fallowed acreage. This evaluation would rely on additional research, in coordination with USDA-NRCS, agricultural sources, and researchers, which recognizes the Valley's unique soil characteristics and agricultural practices to ensure that Valley-specific solutions are considered in this process.

The District committed to undertake scientific research on the PM2.5 content, constituents, and stability during wind events of the many soil types found throughout the Valley. This research would be conducted in close coordination with USDA-NRCS, agricultural sources, researchers through established processes including the San Joaquin Valleywide Air Pollution Study Agency, Policy Committee, and Agricultural Technical Subcommittee.

The District is currently conducting a robust rule development process to evaluate these opportunities, working collaboratively with industry stakeholders, USDA-NRCS, and other agencies to develop proposed rule amendments.

Source Category

This rule is applicable to on-field farming and agricultural operation sites located within the Valley, and was adopted to reduce emissions of PM10 from such operations. Rule 4550 limits fugitive dust emissions from farming operations by requiring CMP plans for farms with 100 acres or more, dairies with 500 or more mature cows, cattle feedlots with 190 or more cows, turkey ranches with 55,000 or more turkeys, chicken ranches with 125,000 or more chickens, and chicken egg ranches with 82,000 or more laying hens.

Rule 4550 specifies that agricultural operations must select at least one CMP from each of the identified applicable CMP categories discussed below, and as many as three CMPs per category, to control PM10 emissions. There are five CMP categories for the cropland source category, four CMP categories for the dairy source category, four CMP categories for the feedlot source category, and five CMP categories for the poultry source category. Animal feeding operation (AFO) sources subject to Rule 4550 that also grow field crops must select CMPs for their field crops, as well as their AFO. The selected CMPs must be noted on the applications provided and then submitted to the District for approval. Completed applications constitute a CMP Plan once approved by the District.

Emissions from agricultural operations vary by many factors, some beyond the control of the agricultural operations. Particulate emissions (primarily PM10) are generated during land preparation activities, harvest activities, and post-harvest activities. Emissions are caused by the mechanical disturbance of the soil by implements and the tractors pulling them, resulting in the entrainment of soil or plant materials into the air. Wind blowing across exposed agricultural land also causes the entrainment of particulates into the air. In addition, particulate emissions can also become entrained from vehicular travel over unpaved roads and unpaved parking/equipment areas. Conservation management practices fall into several broad categories and are intended to reduce emissions as follows:

- The reduction of soil or manure disturbance;
- Soil protection from wind erosion;
- Equipment modifications to physically produce less particulates; and
- Application of water or dust suppressants on unpaved roads and other travel areas to reduce emissions entrained by moving vehicles and equipment.

Fugitive PM2.5 Dust Emissions from Agricultural Operations

Rule 4550 was intended and designed to reduce PM10, and it has been successful in doing so, reducing 35.3 tons per day of PM10 from agricultural operations. However, as discussed in more detail below, recent studies have indicated that the PM2.5 fraction of emissions makes up a small portion of the total particulate emissions from agricultural operations, and therefore Rule 4550 and other conservation management-based rules are less effective at reducing PM2.5.

Additionally, particulate emissions from agricultural operations are geologic in nature (dust). Analysis of data from ambient PM2.5 monitors has demonstrated that these geologic particulate emissions make up a relatively small portion of the overall PM2.5 concentrations during the winter season.[111] In addition, these geologic particulate emissions in the San Joaquin Valley have relatively low toxicity relative to the organic carbon fraction of PM2.5 and to re-suspended road dust.[112]

Accordingly, particulate emissions from agricultural sources do not play a significant role with regard to attainment of the PM2.5 standards addressed by this plan, and Rule 4550 remains primarily a PM10 reduction strategy. For example, the latest available speciation analyses of PM2.5 from the Speciated Trends Network in Bakersfield, Fresno, Modesto, and Visalia found that the annual average geologic fraction during 2020-2022 was 12%, 10%, 8%, and 14%, respectively. Given that PM2.5 emissions from agricultural field operations are generally subject to deposition near their source, the predominant source of this geologic PM2.5 would be urban re-suspended road dust with relatively little contribution from agricultural activities.[113]

[111] CARB. *Meeting PM2.5 Standards in the San Joaquin Valley.* Public Workshop. Fresno, CA. (December 1, 2016). Retrieved from: https://www.arb.ca.gov/planning/sip/sjvpm25/workshopslides.pdf; and
CARB. *Staff Report: Proposed Revision to the PM2.5 State Implementation Plan (SIP) for the San Joaquin Valley, Appendix B: Weight of Evidence Analysis.* Retrieved from: https://www.arb.ca.gov/planning/sip/sjvpm25/2012plan_appendix_b.pdf

[112] Veranth, J., Rielly, C.A., Veranth, M.M., Moss, T.A., Langelier, C.R., Lanza, D.L., & Yost, G.S. (2004). Inflammatory Cytokines and Cell Death in BEAS-2B Lung Cells Treated with Soil Dust, Lipopolysaccharide, and Surface-Modified Particles. *Toxicological Science 82(1)*, 88–96. Retrieved from: http://toxsci.oxfordjournals.org/content/82/1/88.full.pdf+html; and
Rogge, W. F., Hildemann, L. M., Mazurek, M. A., Cass, G. R. and Simoneit, B. R. T. (1993). *Sources of Fine Organic Aerosol—3. Road Dust, Tire Debris, and Organometallic Brake Lining Dust—Roads as Sources and Sinks.* Environmental Science & Technology 27(9), 1892-1904.

[113] Countess, R. (2001). *Methodology for Estimating Fugitive Windblown and Mechanically Resuspended Road Dust Emissions Applicable for Regional Air Quality Modeling*, 10th Annual EPA Emissions Inventory Meeting, Denver, CO. May 1-3, 2001. Retrieved from: https://www3.epa.gov/ttnchie1/conference/ei10/fugdust/countess.pdf

As discussed below, the most recent science has demonstrated that PM2.5 emissions from agricultural field operations had previously been significantly over-estimated in absolute terms due to species differences between the fine and coarse fractions of geologic emissions. For example, in 2003, Countess Environmental estimated the PM2.5/PM10 ratios for the predominant trace elements found in fugitive dust using Valley ambient measurements of such elements. The average ratio for aluminum and silicon was 0.05 and ranged between 0.10 to 0.16 for calcium, titanium, and iron. Based on the relative abundances of these elements in fugitive dust, the overall PM2.5/PM10 ratio was estimated to be 0.06 (6%).[114] This ratio estimate is substantially lower than the ratio of 0.20 that Midwest Research Institute (MRI) previously recommended, based on limited supporting data and broad assumptions, as an interim revision to the PM2.5/PM10 ratio for agricultural crops nationwide in 1996. Note that the MRI's 1996 interim revision to the PM2.5/PM10 ratios for fugitive dust sources was meant to improve the PM2.5/PM10 ratios that MRI had previously developed based on data from cascade impactors in the 1980's, which had also been shown to significantly overestimate PM2.5 emissions. As described by Thomas Pace of EPA at the 2005 US EPA Emissions Inventory Conference, MRI's 1996 interim revision to the PM2.5/PM10 ratios for fugitive dust still appeared to overestimate PM2.5 emissions. Pace's review of the most recent research on PM2.5/PM10 ratios nationally shows a consistent mid-point estimate of between 0.10 and 0.12, which is consistent with the higher-end values seen in the Valley. To summarize, PM2.5 comprises a small fraction of total PM10 emissions from agricultural field operations in the Valley, approximately 6% to 12%.

Pace concludes that both PM2.5 emissions from agricultural field operations as well as their contribution to ambient PM2.5 concentrations had previously been significantly overestimated. Factors that contributed to this previous overestimation of PM2.5 emissions from agricultural operations included: (1) the multiplier used to infer PM2.5 from PM10 emissions, (2) difficulty in obtaining activity data to apply to emission factor algorithms, and (3) modeling transport over-estimation (especially in the treatment of particles near their point of emissions).[115]

In respect to over-estimation of PM2.5 transport, much of the ground level fugitive dust from soil disturbance is likely to be removed close to the source.[116] This is due to the low release height and turbulence which keeps particles temporarily close to the surface

[114] Countess, R. (2003). *Reconciling Fugitive Dust Emission Inventories with Ambient Measurements*, 12th Annual EPA Emissions Inventory Meeting, San Diego, CA. April 29-May 1, 2003. Retrieved from:
https://www.epa.gov/ttn/chief/conference/ei12/fugdust/countess.pdf
https://www.epa.gov/ttn/chief/conference/ei12/fugdust/present/countess.pdf

[115] Pace, T.G., US EPA. (2005). Examination of the Multiplier Used to Estimate PM2.5 Fugitive Dust Emissions from PM10, 14th Annual EPA Emissions Inventory Meeting, Las Vegas, Nevada, April 11 - 14, 2005. Retrieved from:
https://www3.epa.gov/ttnchie1/conference/ei14/session5/pace.pdf
https://www3.epa.gov/ttnchie1/conference/ei14/session5/pace_pres.pdf

[116] Countess, R. (2001). *Methodology for Estimating Fugitive Windblown and Mechanically Resuspended Road Dust Emissions Applicable for Regional Air Quality Modeling*, 10th Annual EPA Emissions Inventory Meeting, Denver, CO. May 1-3, 2001. Retrieved from: https://www3.epa.gov/ttnchie1/conference/ei10/fugdust/countess.pdf; and
Fitz, D., Pankratz, D., Philbrick, R., and Li, G. (2003). *Evaluation of Fugitive Dust Deposition Rates Using Lidar*, 12th Annual EPA Emissions Inventory Meeting, San Diego, CA. April 29-May 1, 2003. Retrieved from:
https://www3.epa.gov/ttnchie1/conference/ei12/fugdust/fitz.pdf
https://www.epa.gov/ttn/chief/conference/ei12/fugdust/present/fitz.pdf

where they are subject to removal by impaction on nearby surfaces, including vegetation and structures. Equally significant in respect to the previous over-estimation of PM10 and PM2.5, earlier grid models ignored all removal processes in the grid cell where the emissions originate. Given that 4 kilometers is a typical grid dimension, a considerable fraction of PM2.5 emitted under normal field operations could and often would be deposited within that cell, but models ignored such deposition.

Wind-blown Dust in the Valley

Although the Valley may occasionally experience wind-blown dust events from time to time, these events typically do not coincide with the winter period in which the PM2.5 concentrations in the Valley are the highest. For example, both Fresno and Bakersfield have seasonal variation in wind speeds throughout the year with the highest average wind speeds in Fresno occurring from April to July with highest wind speeds in late May and early June, and the highest average wind speeds in Bakersfield occurring from late March to mid-July with the highest wind speeds typically in late May.[117] These high wind events are less likely to occur during the winter season, in which PM2.5 concentrations are elevated during stagnation events that are characterized by low wind speeds, moderate temperatures, vertical atmospheric stability, and high relative humidity.

These high wind events primarily cause higher PM10 concentrations, but rarely result in elevated PM2.5 concentrations. In addition to the rarity of elevated PM2.5 concentrations during high-wind events, the PM2.5 values recorded during the strong stagnation periods of the winter season are usually much higher than those recorded during wind events. Because of this, the Valley's PM2.5 design values are driven primarily by high winter-time concentrations, mostly due to organic carbon and the secondary formation of ammonium nitrate. Comparatively, the geologic component of the Valley's peak PM2.5 concentrations is only a fraction of the mass formed through secondary processes and other sources (less than 6%).[118]

As a result of the facts discussed above, the wind events experienced in the Valley are not a significant contributor to the 24-hr PM2.5 attainment challenges for the region, and have essentially no impact on annual PM2.5 averages.

How does District Rule 4550 compare with federal and state rules and regulations?

Federal Regulations

There are no Alternative Control Techniques, Control Techniques Guidelines, or New Source Performance Standards applicable to this source category.

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[117] Retrieved from: https://weatherspark.com

[118] CARB. *Staff Report: Proposed Revision to the PM2.5 State Implementation Plan (SIP) for the San Joaquin Valley, Appendix B: Weight of Evidence Analysis.* (2012). Retrieved from: https://www.arb.ca.gov/planning/sip/sjvpm25/2012plan_appendix_b.pdf

State Regulations

There are no state regulations that are applicable to this source category.

How does District Rule 4550 compare to rules in other air districts?

Rule 4550 has served as a model for other regions seeking to reduce fugitive particulate emissions from agricultural sources. For this evaluation, the PM2.5 reduction requirements and applicability of Rule 4550 were compared to analogous rules in other air districts and states to determine the stringency of Rule 4550 compared to those other rules. The District found four analogous rules, in Arizona, Eastern Kern APCD, Imperial County APCD, and South Coast AQMD.

Notably, the District's examination found that each of these rules were developed to reduce PM10 emissions from agricultural operations in PM10 non-attainment areas. This was the situation for the District CMP rule, as well – in fact, the District believes that this ground-breaking CMP program was a significant contributor to the Valley's subsequent attainment of the PM10 standard.

None of these rules were developed or modified for the purpose of generating PM2.5 reductions, or as a part of a PM2.5 attainment planning process. As discussed above, PM2.5 is a small fraction of the PM10 from agricultural operations, and the effectiveness of controlling PM2.5 with such measures is not as well understood as the effectiveness of controlling PM10. Since the degree of effectiveness in controlling PM2.5 is not well understood, the corresponding cost effectiveness of implementing CMPs for the purposes of controlling PM2.5 is also unknown. Because of these factors, none of the three rules listed below can be considered as establishing BACM for PM2.5.

Nonetheless, the District compared emission limits, optional control requirements, and work practice standards in District Rule 4550 to comparable requirements in rules from the following areas:

- Arizona Department of Environmental Quality R18-2-610.01, R18-2-610.02, and R18-2-610.03 (Amended July 2, 2015, July 2, 2015, and November 3, 2021, respectively)[119]
- Eastern Kern APCD Rule 402.2 (Amended January 13, 2022)[120, 121]
- Imperial County APCD Rule 806 (Amended October 16, 2012)[122]
- South Coast AQMD Rule 403 (Amended June 3, 2005)[123]

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[119] Arizona Department of Environmental Quality. Arizona Administrative Code Title 18, Chapter 2, pp. 22-2, pp. 90-97. Retrieved from: https://apps.azsos.gov/public_services/Title_18/18-02.pdf
[120] EKAPCD. *Rule 402.2 (Agricultural Operations)*. (Amended January 13, 2022). Retrieved from: http://www.kernair.org/Rule%20Book/4%20Prohibitions/402_2%20Agricultural_Operations.pdf
[121] Note: EKAPCD Rule 402.2 was originally adopted in March 2015. EKAPCD withdrew the 2015 version of Rule 402.2 from the SIP through formal request on March 4, 2021, based on rule deficiencies identified by U.S. EPA. EKAPCD adopted the new version of Rule 402.2 on January 13, 2022.
[122] ICAPCD. *Rule 806 (Conservation Management Practices)*. (Amended October 16, 2012). Retrieved from: https://apcd.imperialcounty.org/wp-content/uploads/2020/05/1RULE806.pdf
[123] SCAQMD. *Rule 403 (Fugitive Dust)*. (Amended June 3, 2005). Retrieved from: https://www.aqmd.gov/docs/default-source/rule-book/rule-iv/rule-403.pdf?sfvrsn=4

In their 2020 approval of the District's *2018 PM2.5 Plan* for the 2006 PM2.5 NAAQS, EPA concluded that Rule 4550 continues to establish BACM and MSM control requirements for this source category. In their Technical Support Document,[124] EPA specifically cited the significantly superior enforcement mechanisms in Rule 4550, including:

- It is the only rule to require applications to be filed, specifying the CMPs to be employed;
- It requires an approval process of the chosen CMPs, unlike the other analogous rules; and
- It is the only rule to require owner/operators to maintain records for five years.

The District finds that Rule 4550 continues to implement the most stringent levels of control when compared to analogous rules from other areas. Therefore, no additional comparison is needed at this time.

Potential Emission Reduction Opportunities

Beyond the review of current regulations and rule requirements, the District reviewed the feasibility of technologies and measures implemented in other regions and potential new technologies and measures that may be feasible for implementation in the near future. However, the District did not identify additional emission reduction opportunities at this time.

Evaluation Findings

Rule 4550 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

[124] EPA. *Technical Support Document*, *EPA Evaluation of BACM/MSM for the San Joaquin Valley PM2.5 Plan for the 2006 PM2.5 NAAQS*, pp. 26-30. (February 2020). Retrieved from: https://www.regulations.gov/document/EPA-R09-OAR-2019-0318-0005

2.16 RULE 4692 (COMMERCIAL CHARBROILING)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	3.02	3.07	3.13	3.22	3.31	3.38	3.41
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day						
PM2.5	3.01	3.07	3.13	3.22	3.31	3.37	3.41
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00

District Rule 4692 Description

District Rule 4692, adopted March 21, 2002, requires the installation and operation of PM control devices on chain-driven commercial charbroilers that cook 400 pounds of meat or more per week. Charbroiler exhaust transfers through the catalytic oxidizer with little loss of temperature. As high-temperature exhaust goes through the heated catalyst, PM and VOC are oxidized to carbon dioxide and water vapor. This chemical reaction releases energy that heats the catalyst and transfers it to a heat recovery system. Through current Rule 4692 requirements, affected chain-driven commercial charbroilers are required to have emissions control devices that achieve 83% control efficiency for PM and 86% control efficiency for VOC.

The District has attempted to impose similar requirements for underfired charbroiling operations, however the unavailability of a feasible and cost-effective control technology has been a barrier to establishing these requirements. Other air districts in California have encountered similar difficulties in identifying and requiring compliant control technologies for underfired charbroilers.

The District has contributed substantial time and effort into researching the emissions produced by underfired charbroilers in order to form a sound approach to controlling the emissions. Since 2009, the District has partnered with SCAQMD, BAAQMD, and EPA to further the research and evaluation of emission control technologies for underfired charbroilers. Through this effort, underfired charbroiler technology assessments have been conducted at UC Riverside College of Engineering's Center for Environmental Research & Technology (CE-CERT). The District provided in-kind technical support and the research was funded with over $500,000 in contributions from SCAQMD, BAAQMD, and EPA. This effort led to the establishment of published testing methodology, SCAQMD Method 5.1, which has been used as a benchmark methodology to standardize the testing of control efficiencies of kitchen exhaust pollution control units.

Rule 4692 was amended on June 21, 2018, to better understand emissions from underfired charbroilers in the Valley, and as an early measure in support of the District's commitment in the *2018 PM2.5 Plan*. The 2018 amendments added reporting and registration requirements for commercial underfired charbroiler units, including Permit-Exempt Equipment Registration (PEER) requirements for units with a meat throughput greater than 400 pounds/week, or greater than 10,800 pounds/year, not to exceed 875 pounds/week. Upon adoption of the regulatory amendment, the District conducted outreach to affected restaurants, with the vast majority of restaurants subject to the reporting requirement now having submitted the required information. To date, the District has received over 4,100 one-time reports, of which 878 restaurants have reported operation of an underfired charbroiler. Of these 878 restaurants, 145 have reported a cooking throughput of at least 400 lbs of meat per week and have subsequently obtained a required PEER.

Additionally, the District created the Restaurant Charbroiler Technology Partnership (RCTP) program with the goal of reducing PM2.5 emissions from underfired commercial charbroilers. The program was initially allocated with $750,000 of incentive funding to fully cover all emissions control device installation costs as well as two years of device maintenance. RCTP initially struggled to find restaurants interested in participating in the program despite the program's willingness to cover all associated costs. Despite the District's efforts in promoting available funding under the RCTP program, the District has faced difficulty in finding restaurants willing to partner with the District to demonstrate new technologies. To date, only one restaurant, the Habit Burger Grill, has successfully completed two years of demonstration of a Molitron wet scrubber in their Stockton restaurant. Initially, the project experienced hood fan sizing issues, resulting in the restaurant being smoked out and forced to close temporarily. The Habit Burger Grill has subsequently installed these control devices on additional new restaurants, with some of these installations in the Valley.

In 2019, the District made an even larger concerted effort to conduct outreach to restaurants in the San Joaquin Valley regarding incentives available through RCTP. Through this outreach effort, the District received only 15 RCTP interest cards out of the over 4,200 restaurants that were contacted to comply with the 2018 Rule 4692 reporting and registration requirements. After discussing RCTP with these restaurants in more detail, none of these restaurants considered moving forward after this additional outreach.

In addition, the District tailored its approach and made direct contact with five prominent Valley restaurants, which resulted in a great deal of interest to evaluate the feasibility of installing the underfired emission control technology on their existing operations, with the understanding that all costs of the technology and two year maintenance would be covered through the RCTP program. District staff conducted multiple site visits to these operations, working with the restaurant owner/operator, engineering consultants, and technology vendors. Initial control system designs, quotes from vendors, and installation quotes from contractors were obtained and the feasibility of the technologies were fully assessed for each of the restaurants. However, after conducting a lengthy detailed analysis, none of the restaurants moved forward with the demonstration due to feasibility issues related to the installation of the control devices and local permitting challenges, as further described below, and concerns about the cost of maintenance after the funded two-year demonstration period concluded under RCTP. The District is still actively pursuing restaurants for demonstration opportunities in the Valley.

How does District Rule 4692 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Techniques Guidelines, Alternative Control Techniques, or New Source Performance Standards applicable to this source category.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4692 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4692 to comparable requirements in rules from the following California nonattainment areas:

- Bay Area AQMD Regulation 6, Rule 2 (Amended December 5, 2007)[125]
- New York Department of Environmental Protection Title 24 of the Administrative Code, Section 24-149.4 (Amended November 6, 2016)[126]
- South Coast AQMD Rule 1138 (Adopted November 14, 1997)[127]
- Ventura County APCD Rule 74.25 (Adopted October 12, 2004)[128]

In their 2020 approval of the District's *2018 PM2.5 Plan* for the 2006 PM2.5 NAAQS, EPA found that Rule 4692 continues to establish BACM and MSM control requirements for this source category. In their Technical Support Document,[129] EPA stated the following:

> *"Rule 4692 implements the most stringent measures adopted or demonstrated to be technically and economically feasible for commercial chain-driven charbroilers, and we are not aware of control measures for existing under-fired*

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[125] BAAQMD*. Regulation 6 Rule 2 (Commercial Cooking Equipment).* (Amended December 5, 2007). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-6-rule-2-commercial-cooking-equipment/documents/rg0602.pdf?la=en&rev=42fc0966398c43f9b585572708a5ea70

[126] New York Department of Environment Protection*. Title 24 of the Administrative Code, Section 24-149.4 (Commercial Char Broilers).* (Amended November 6, 2016). Retrieved from: https://www1.nyc.gov/assets/dep/downloads/pdf/air/air-pollution-control-code.pdf

[127] SCAQMD. *Rule 1138 (Control of Emissions from Restaurant Operations).* (Adopted November 14, 1997). Retrieved from: https://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1138.pdf?sfvrsn=4

[128] VCAPCD. *Rule 74.25 (Restaurant Cooking Operations).* (Adopted October 12, 2004). Retrieved from: http://www.vcapcd.org/Rulebook/Reg4/RULE%2074.25.pdf

[129] EPA. *Technical Support Document*, *EPA Evaluation of BACM/MSM for the San Joaquin Valley PM2.5 Plan for the 2006 PM2.5 NAAQS*, pp. 30-36. (February 2020). Retrieved from: https://www.regulations.gov/document/EPA-R09-OAR-2019-0318-0005

charbroilers that are technologically and economically feasible for implementation in the SJV."

The District reviewed all rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4692 continues to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rule is demonstrated below.

New York Department of Environmental Protection (NYDEP)

- City of New York Title 24 of the Administrative Code, Section 24-149.4 (Emission Reduction Technologies for Char Broilers)

	SJVAPCD Rule 4692	NYDEP Title 24 §24-149.4
Applicability	Chain-driven charbroilers and underfired charbroilers at commercial cooking operations.	Chain-driven charbroilers and underfired charbroilers at commercial cooking operations.
Exemption	Charbroilers that cook <400 lbs of meat per week, or ≤10,800 lbs of meat per year and the total amount of meat cooked per week is <875 lbs.	Charbroilers that cook <875 lbs of meat per week.
Requirements	Requires that chain-driven charbroilers reduce PM emissions by 83% through the installation of an approved catalytic oxidizer. Registration requirements for under-fired charbroilers. Weekly record-keeping requirement for both charbroiler categories.	Requires catalytic oxidizer or control of PM10 by 75% for chain-driven charbroilers. Registration requirement for existing under-fired units. New under-fired units required to install control devices to limit PM emissions by 75% (currently unenforced).

The NYC DEP regulation, adopted in May 2016, requires the installation of control devices certified to provide at least 75% emissions reductions for new restaurants with underfired charbroilers that cook 875 pounds or more of meat per week. Based on staff-level discussions, NYC DEP does not currently have any known installations of these devices. Therefore, the requirements of District Rule 4692 are more stringent that those found in NYC's Section 24-149.4 for chain-driven charbroilers.

Potential Emission Reduction Opportunities

In December 2020, the District Governing Board approved a multipronged strategy to identify opportunities to reduce emissions from underfired charbroilers. Through this strategy, the District will continue to evaluate emission reduction opportunities for this source category.

Although a variety of technologies for capturing emissions from underfired charbroilers have been tested over the years, ESPs and mechanical or media filtration are the most widely installed technologies for controlling particulate emissions from commercial underfired charbroilers. Below are general descriptions of each technology.

- **Electrostatic Precipitator (ESP):** This technology uses electrostatic processes to capture particles on electrically charged plates. ESPs are complex technology, but highly automated, and the operation costs include electricity and water usage. In addition, wastewater collection and discharge requirements must be met, which involves washing collection plates. ESPs are more expensive to install initially, but have lower maintenance costs than the mechanical filtration units (generally about half of the maintenance costs of the filter units) and have a more effective control of the small particulates emitted by charbroiling.

- **Filtration (Mechanical or Media):** This technology uses groups of mechanical filters to capture particles. It is mechanically simpler than other technologies and the operation costs include electricity and filter replacements. Mechanical filtration units have been widely installed as pollution control devices for kitchen emissions, but maintenance of these units may be cost-prohibitive for mid-to high-volume underfired charbroiling operations due to the ongoing expense of changing the filters, and the large footprint of the units can make installation potentially infeasible.

- **Regenerative Filters:** Regenerative filters capture particles often on a catalyst surface, which then safely removes the particles during the regeneration process, thus allowing the filter to continue capturing particles with little maintenance or filter replacements. Regenerative filters are an emerging technology that has yet to be commercially proven in this source category. The District has had discussions with PureFlame and KhanTec to evaluate the feasibility of their technology. Notably, both technologies lack UL 8782 certification, and do not have installations in the United States.

- **Wool Filters:** Wool filters are another form of media filtration that uses wool instead of traditional filter media. A significant portion of PM2.5 produced by underfired charbroilers measure less than one micron, however, wool filters lack the ability to filter submicron particles at a high control efficiency thus rendering wool filters less efficient at reducing PM2.5.

The evaluation of installing emissions control technology on existing Valley restaurants through RCTP provided many insights as to the cost and technological feasibility of available controls. In addition to supporting and evaluating Valley-based underfired charbroiler control technology demonstrations, District staff has conducted an extensive review and assessment of underfired charbroiler control technology installations. This review included reaching out to other regulatory agencies in California and across the nation, technology manufacturers, and restaurants both inside and outside of the Valley to better understand the control technologies available for underfired charbroilers and real-world costs and experiences related to these technologies. While the District's evaluation has been successful in identifying potential underfired charbroiling control technologies, many questions remain with respect to understanding the feasibility and cost of these technologies, and whether restaurants can successfully operate and maintain these systems, as described in more detail below:

- **Installation cost of controls can be prohibitively expensive:** The cost of control units themselves are expensive, ranging from $42,500 up to $149,303 for the device itself. This does not take into account additional ducting, exhaust fan upgrades, or operation and maintenance costs. Recent discussions with control device manufacturers indicated that maintenance costs are significant and can quickly outweigh purchase costs within a few year. This fact is also supported by the previous District demonstration project, which required $23,956 of annual maintenance.

- **Retrofitting controls on existing restaurants can be prohibitively expensive and technologically infeasible:** Based on discussions with restaurant operators, technology vendors, and other regulatory agencies, it can be extremely difficult and cost-prohibitive to add controls on existing restaurants. The installation process may require structural, electrical, or water-line modifications that substantially increase total project costs compared to new restaurants. In addition to significant purchase and installation costs, the installation process may require the restaurant to temporarily shut down, resulting in loss of revenue. The District's control strategy seeks to not disrupt business from being carried out, therefore adding another layer of cost and complexity to manage for existing restaurants. Furthermore, the existing restaurant may not have the authority to make changes to the building if the space is leased and the landlord is unwilling to accommodate any changes.

- **Maintenance of controls can be prohibitively expensive:** Regular maintenance of control devices is critical to ensure control effectiveness is maintained. All commercial technologies applicable to control underfired charbroilers are designed to capture PM2.5 and require regular maintenance to remove particles, ensure proper airflow, and maintain control efficiency. ESPs require regular cleaning of the plates capturing particles, as ESPs lose control efficiency when these plates are covered in grease particles and filters clog over time. Discussions with manufacturers indicate that maintenance costs are dependent on the control technology implemented and the type and volume of food cooked, and that most facilities require maintenance on a weekly to monthly basis.

- **Maintenance requires specially trained staff that may not be accessible to all restaurants:** Control device cleaning can be a complex process, requiring specially trained staff. Many manufacturers recommend that their staff or a trusted professional company perform maintenance. Training restaurant staff to perform this task are often not be feasible, and service companies capable of performing the maintenance may not be readily available nearby. Travel costs are another factor that needs be taken into account when determining maintenance costs. Any delays in required maintenance could cause significant economic impacts to restaurants.

- **Regenerative filters lack UL 8782 certification:** Regenerative filters appear to be a promising technology that seek to limit the amount of maintenance required to control PM2.5 since the device is self-cleaning by design. However, regenerative filters have not been commercially demonstrated to control underfired charbroiler emissions in the US. The lack of UL 8782 certification currently prevents two manufacturers, PureFlame and KhanTec, from entering the market. The District has had previous working relationship with KhanTec and struggled to install their device due to fire safety concerns since the device had not received UL 8782 certification. Discussions with PureFlame also present the same concerns, as well as lacking a fire suppression system. The District cannot recommend using a control device that may become a safety hazard.

Cost Analysis for New Restaurants

District Rule 4692 (Commercial Charbroiling) reduces emissions by requiring catalytic oxidizers for chain-driven charbroilers that meet rule applicability thresholds. Charbroiler exhaust transfers through the catalytic oxidizer with little loss of temperature. As high-temperature exhaust goes through the heated catalyst, particulate matter (PM) and VOC are oxidized to carbon dioxide and water vapor. This chemical reaction releases energy that heats the catalyst and transfers it to a heat recovery system. Rule 4692 requires emission controls for chain-driven charbroilers that cook 400 pounds of meat or more per week.

A variety of technologies for capturing emissions from underfired charbroilers have been tested over the years, including electrostatic precipitators (ESP), mechanical or media filtration, and wet scrubbers. ESPs and mechanical or media filtration are the most widely installed technologies for controlling PM from commercial underfired charbroilers. However, District analysis found no cost-effective technologies have been demonstrated as achieved in practice to date. As such, the rule currently does not have control requirements specific to underfired charbroilers.

This analysis uses the meat throughput data from each facility required to obtain a PEER for their operation, which cook over a threshold amount of meat and meat substitute products on an underfired charbroiler. According to the District's PEER data, 157 restaurants cooked at least 10,800 pounds of meat annually. Using the District's commercial cooking methodology,[130] the median PM2.5 emissions from each of these restaurants was 808 pounds annually.

The District conducted a cost analysis using the methods in EPA's Cost Manual.[131] The Cost Manual has relative estimates of all costs associated with ESPs including purchase price, installation, engineering, fabrication, contractors, and many more. The Cost Manual begins with the purchase price, then estimates all other costs based on a percentage of the purchase price.

The total capital investment required for ESPs was calculated using the formula in Table 3.16 of the Cost Manual. The formula from Table 3.16 was used to evaluate the lower and upper end of ESP purchase costs of $42,500 and $149,303 respectively. The Cost Manual estimates the total capital investment of $112,336 needed for ESPs with a

[130] SJVAPCD. 2006 Area Source Emissions Inventory Methodology 690 – Commercial Cooking Operations. Retrieved from: https://www.valleyair.org/Air_Quality_Plans/EmissionsMethods/MethodForms/Current/CommercialCookin g2006.pdf

[131] EPA. *Air Pollution Control Cost Manual, Section 6, Particulate Matter Controls, Chapter 3: Electrostatic Precipitators*. (September 1999). Retrieved from: https://www.epa.gov/sites/default/files/2020-07/documents/cs6ch3.pdf

purchase cost of $42,500. The total capital investment increases to $394,638 for devices with a $149,303 purchase cost. Notably, these capital costs do not include site preparation or building modifications, which would require additional investment from the facility.

When combined with operation and maintenance costs, even less expensive ESP devices are not cost effective solutions to reducing emissions from this source category. Based on previous District experience and discussions with manufacturers, the District estimates that $12,000 to $24,000 of annual operation and maintenance costs are required to keep pollution control devices performing properly. Maintenance typically includes but is not limited to media filter replacements, carbon filter replacements, duct or hood cleaning, or ESP plate cleaning. As one example, the District's demonstration of a wet scrubber with media filtration through the RCTP had reported $23,956 of annual maintenance costs. Notably, regular maintenance is required to keep ESPs control efficiency, which can drop to below 30% if not properly maintained. Although facilities are required to install a control device, it is only effective if maintenance is performed regularly. The District has recently had discussions with various vendors that have integrated automated cleaning functions; however, these units still require professional cleaning on a regular basis.

Table 2-4 Direct Costs

	EPA Cost Manual Formula	Low Estimate	High Estimate
ESP + auxiliary equipment	1.0 A	$42,500	$149,303
Instrumentation	0.1 A	$4,250	$14,930
Sales Tax	0.03 A	$1,275	$4,479
Freight	0.05 A	$2,125	$7,465
Direct Cost Total	**B = 1.18 A**	**$50,150**	**$176,178**

Table 2-5 Direct Installation Costs

	EPA Cost Manual Formula	Low Estimate	High Estimate
Foundations and Supports	0.04 B	$2,006	$7,047
Handling and Fabrication	0.50 B	$25,075	$88,089
Electrical	0.08 B	$4,012	$14,094
Piping	0.01 B	$502	$1,762
Insulation for Ductwork	0.02 B	$1,003	$3,524
Painting	0.02 B	$1,003	$3,524
Direct Installation Costs Total	**0.67 B**	**$33,601**	**$118,039**

Table 2-6 Indirect Costs

	EPA Cost Manual Formula	Low Estimate	High Estimate
Engineering	0.20 B	$10,030	$35,236
Construction	0.20 B	$10,030	$35,236
Contractor	0.10 B	$5,015	$17,618
Start-up	0.01 B	$502	$1,762
Performance Test	0.01 B	$502	$1,762
Model Study	0.02 B	$1,003	$3,524

Contingencies	0.03 B	$1,505	$5,285
Total Indirect Costs	**0.57 B**	**$28,586**	**$100,421**

Table 2-7 Other Costs

	EPA Cost Manual Formula	Low Estimate	High Estimate
Site Preparation	SP	As Required	As Required
Buildings	Bldg	As Required	As Required

Table 2-8 Total Capital Investment

	EPA Cost Manual Formula	Low Estimate	High Estimate
Total	2.24 x B	**$112,336** *+ SP and Bldg*	**$394,638** *+ SP and Bldg*

The cost effectiveness was calculated twice to give a low and high total capital investment estimate by summing annualized one-time costs (annualized over a 10-year period using a 4 percent discount rate) and annual operation and maintenance costs. The District estimates a cost effectiveness of $74,424 per ton of PM2.5 controlled for ESP devices costing $42,500. These costs inflate to $209,180 per ton of PM2.5 controlled for ESP devices costing $149,303. As expected, the elevated purchase costs leads to excessive costs that will not be feasible for restaurant owners to incur an annual cost ranging from $25,850 to $72,655 of annual costs to control emissions. The average Valley restaurant only expects to profit $44,000 annually, which would require the owner to sacrifice approximately 2.80 to 9.87 years' worth of profits to cover the total capital investment.[132]

Table 2-9 Cost Effectiveness Analysis for Underfired Charbroiler Controls

	Purchase Costs	Total Capital Investment	O&M (annual)	Annualized Cost	Cost Effectiveness (PEER Median Emissions)
Lowest Cost Estimate	$42,500	$112,336	$12,000	$25,850	**$74,424**
Highest Cost Estimate	$149,303	$394,638	$24,000	$72,655	**$209,180**

Cost Analysis for Existing Restaurants

Based on discussions with restaurant operators, technology vendors, and other regulatory agencies, it can be extremely difficult and cost-prohibitive to add controls on existing restaurants. The installation may require structural, electrical, or water-line modifications that may not be feasible. This makes installation costs much higher for existing restaurants compared to new restaurants that can integrate emissions controls into the design. The existing structure may not have the necessary space or structural support for the control unit. Furthermore, the existing restaurant may not have the authority to make changes to the building if the space is leased and the property owner is unwilling to accommodate. EPA's Cost Manual estimates that the total capital investment for existing restaurants would be 1.3 to 1.5 times more expensive than the

[132] SJVAPCD. *Proposed Commercial Underfired Charbroiling Emission Reduction Strategy*. (December 17, 2020). Retrieved from: https://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2020/December/final/11.pdf

total capital investment for new restaurants, with an estimated total capital investment ranging from $146,036 to $591,957, which would be far less cost effective than the already high cost effectiveness values shown previously for new restaurants.

District Commercial Underfired Charbroiling Emission Reductions Strategy

In recognition of the above mentioned challenges, the District Governing Board adopted a multipronged strategy to promote emission reductions from this category, while minimizing the impact on restaurants during the COVID-19 pandemic. This strategy, approved by the Governing Board in December 2020, will require significant effort by the District through creating enhancements to the RCTP program, developing and providing guidance to local agencies for the development of ordinances, providing education to local agencies on the health impact of commercial cooking emissions, working with CARB as they consider developing a statewide Suggested Control Measure, working with CARB/EPA in making improvements to the emissions inventory for commercial underfired charbroiling, and formalizing the restaurant workgroup to stay in touch with current industry conditions and to continue to develop and deploy underfired charbroiler technology. In addition to this effort, the District continues to coordinate with CARB and EPA on feasibility of technology, and advocates for EPA and CARB to establish a new state/federal underfired charbroiler technology certification and demonstration program. To help address community impacts associated with commercial underfired charbroiling operations, this program would establish uniform certification requirements for vendors of emissions control technologies, and support the real-life demonstration of these technologies. Currently, there is no uniform certification program in place, and no technologies have been certified under regional programs. Given the community-level importance of reducing emissions from large underfired charbroiling operations, establishing a uniform certification and demonstration program would significantly accelerate the development and deployment of these technologies.

Evaluation Findings

Rule 4692 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.17 RULE 4702 (INTERNAL COMBUSTION ENGINES)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	0.36	0.34	0.31	0.28	0.26	0.24	0.24
NOx	6.68	6.26	5.52	4.86	4.36	4.02	3.93
	Winter Average - Tons per day						
PM2.5	0.29	0.28	0.25	0.24	0.22	0.21	0.21
NOx	5.02	4.74	4.20	3.72	3.38	3.14	3.08

District Rule 4702 Description

District Rule 4702 applies to any internal combustion (IC) engine rated at 25 brake horsepower (bhp) or greater. The purpose of this rule is to limit NOx, CO, VOC, and SOx emissions from units subject to this rule. Rule 4702 has significantly reduced emissions from non-agricultural and agricultural IC engines, with substantial investments made by the affected sources to comply with the rule.

On August 19, 2021, the District Governing Board adopted amendments that lowered emission limits for NOx and VOCs for several categories of engines, established PM requirements for all categories of IC engines affected by the rule, and established SOx control requirements for agricultural engines.

How does District Rule 4702 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Techniques Guidelines applicable to this source category.

A. Alternative Control Techniques (ACT)

- *Alternative Control Techniques Document – NOx Emissions from Stationary Reciprocating Internal Combustion Engines (EPA-453/R-93-032 1993/07, updated 2000/09)*

The District evaluated the requirements contained within the ACT for Stationary Reciprocating Internal Combustion Engines and found no requirements that were more stringent than those already in Rule 4702.

B. New Source Performance Standards (NSPS)

- *40 CFR 60 Subpart IIII – Standards of Performance for Stationary Compression Ignition Internal Combustion Engines (2020/12 and 2021/06)*

The District evaluated the requirements contained within Subpart IIII and found no requirements that were more stringent than those already in Rule 4702.

- *40 CFR 60 Subpart JJJJ – Standards of Performance for Stationary Spark Ignition Internal Combustion Engines (2020/12 and 2021/06)*

The District evaluated the requirements contained within Subpart JJJJ and found no requirements that were more stringent than those already in Rule 4702.

State Regulations

- *17 CCR §93114 – Airborne Toxic Control Measure to Reduce Particulate Emissions from Diesel-Fueled Engines—Standards for Nonvehicular Diesel Fuel (2003/07)*
- *17 CCR §93115 – Airborne Toxic Control Measure for Stationary Compression-Ignition Engines (2004/02)*

The District implements the requirements of 17 CCR §§93114 and 93115 through Rule 4702 and the District's new source review permitting program (Rule 2201).

- *17 CCR §93116 – Airborne Toxic Control Measure for Diesel Particulate Matter from Portable Engines Rated at 50 Horsepower and Greater (2018/08)*

The District evaluated the requirements contained within 17 CCR §93116 and found no requirements that were more stringent than those already in Rule 4702.

How does District Rule 4702 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4702 to comparable requirements in rules from the following nonattainment areas:

- Bay Area AQMD Regulation 9, Rule 8 (Amended July 25, 2007)[133]
- Sacramento Metropolitan AQMD Rule 412 (Adopted June 1, 1995)[134]
- San Diego County APCD Rule 69.4.1 (Adopted July 8, 2020)[135]

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[133] BAAQMD. *Regulation 9, Rule 8 (Nitrogen Oxides and Carbon Monoxide from Stationary Internal Combustion Engines)*. (Amended July 25, 2007). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-8-nitrogen-oxides-and-carbon-monoxide-from-stationary-internal-combustion-engines/documents/rg0908.pdf?la=en
[134] SMAQMD. *Rule 412 (Stationary Internal Combustion Engines Located at Major Stationary Sources of NOx)*. (Adopted June 1, 1995). Retrieved from: http://www.airquality.org/ProgramCoordination/Documents/rule412.pdf
[135] SDAPCD. *Rule 69.4.1 (Stationary Reciprocating Internal Combustion Engines).* (Adopted July 8, 2020). Retrieved from: https://www.sdapcd.org/content/dam/sdapcd/documents/rules/current-rules/Rule-69.4.1.pdf

- South Coast AQMD Rule 1110.2 (Amended November 1, 2019)[136]
- Ventura County APCD Rule 74.9 (Amended November 8, 2005)[137]

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4702 continues to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rules is demonstrated below.

San Diego County APCD

- SDAPCD Rule 69.4.1 (Stationary Reciprocating Internal Combustion Engines)

	SJVAPCD Rule 4702		SDAPCD Rule 69.4.1
Applicability	IC engines rated at ≥25 bhp.		IC engines rated at ≥50 bhp.
Exemptions	• Limited to operate >100 hrs/yr • De-rated engine that has been physically limited and restricted by permit to an operational level of <50 hp not used in agricultural operation (prior to 06/01/04) • De-rated engine that has been physically limited and restricted by permit to an operational level of <50 bhp used in agricultural operation (prior to 06/01/05)		• Engines used exclusively in connection with a structure designed for and used as a dwelling for not more than four families • Engines used exclusively in agricultural operations for the growing of crops or the raising of fowl or animals • Any engine when operated exclusively within a permitted test cell solely for the research, development, or testing of gas turbine engines, reciprocating IC engines, or their components • Any engine used exclusively in conjunction with military tactical support equipment
Requirements			
Non-Agricultural Operation IC Engines (ppmv @ *15% oxygen on a dry basis)*			
Rich-Burn	Waste Gas-Fueled	11	50
	Cyclic Loaded, Field Gas Fueled	11	No Such Category
	Limited Use	11	No Such Category
	Not Listed Above	11	Existing: 25 New/Replacement: 11
Lean-Burn	Limited Use	11	No Such Category
	Used for Gas Compression	40, or 93% reduction	No Such Category
	Waste Gas-Fueled	40, or 90% reduction	65
	Not Listed Above	11	65

[136] SCAQMD. *Rule 1110.2 (Emissions from Gaseous- and Liquid-Fueled Engines)*. (Amended November 1, 2019). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1110-2.pdf
[137] VCAPCD. *Rule 74.9 (Stationary Internal Combustion Engines)*. (Amended November 8, 2005). Retrieved from: http://www.vcapcd.org/Rulebook/Reg4/RULE%2074.9.pdf

	SJVAPCD Rule 4702	SDAPCD Rule 69.4.1
Agricultural Operation Spark-Ignited IC Engines (ppmv @ *15% oxygen on a dry basis)*		
Rich-Burn[138]	11, or 0.15 g/bhp-hr	New/Replacement: 90
Lean-Burn[139]	43, or 0.6 g/bhp-hr	New/Replacement: 150
Agricultural Operation Compression-Ignited IC Engines[140] (ppmv @ *15% oxygen on a dry basis)*		
	Tier 3 or Tier 4 Certified IC Engine	Exempt

The District found the requirements contained within SDAPCD Rule 69.4.1 are not more stringent than those already in District Rule 4702. Therefore, District Rule 4702 is as stringent as or more stringent than SDAPCD Rule 69.4.1.

South Coast AQMD

- SCAQMD Rule 1110.2 (Emissions from Gaseous- and Liquid-Fueled Engines)

	SJVAPCD Rule 4702	SCAQMD Rule 1110.2
Applicability	IC engines rated at ≥25 bhp.	Stationary and portable IC engines rated >50 bhp.
Exemptions	• Limited to operate <100 hrs/yr • De-rated engine that has been physically limited and restricted by permit to an operational level of <50 hp not used in agricultural operation (prior to 06/01/04) • De-rated engine that has been physically limited and restricted by permit to an operational level of <50 bhp used in agricultural operation (prior to 06/01/05)	• Engines powering orchard wind machines • Emergency engines permitted to operate no more than 200 hrs/yr • Laboratory engines used in research and testing purposes • Engines operated for purposes of performance verification and testing • Auxiliary engines used to power other engines or gas turbines during start-ups • Portable engines that are registered under the state Portable Equipment Registration Program (PERP) • Engines operating on San Clemente Island • Tier 4 certified stationary agricultural IC engines for which the electric utility rejected an application for an electrical line extension to the engine location or that do not qualify for Carl Moyer Program funding • IC engine start-up periods, until sufficient operating temperatures are reached for proper operation of emission control equipment or for the tuning of the engines and/or emission control equipment, and engine shutdown periods. The periods shall not exceed 30 minutes, unless a longer period, not exceeding two hours, is approved in writing

[138] There are only 2 rich-burn spark ignited engines operating in SCAQMD per discussions with SCAQMD staff.
[139] There are no lean-burn spark ignited ag engines operating in SCAQMD per discussions with SCAQMD staff.
[140] Information from SCAQMD indicates that there are no stationary non-emergency diesel IC engines that operate in the SCAQMD.

	SJVAPCD Rule 4702		SCAQMD Rule 1110.2
			• IC engine start-ups, after an engine overhaul or major repair, or the replacement of catalytic emission control equipment, for a period not to exceed four operating hours • Initial commissioning of a new engine for a period not exceeding 150 operating hours • Engines rated ≤100 bhp used exclusively for electrical generation at remote two-way radio transmission towers where no utility, electricity, or natural gas is available within a ½ mile radius, and is fired exclusively on diesel #2, compressed natural gas, or LPG • NOx emissions from existing IC engines subject to SCAQMD RECLAIM Program (pursuant to SCAQMD Rule 2001 – RECLAIM Applicability) • Engines operated in either the Southern California Coastal Waters or Outer Continental Shelf Waters that power cranes and are certified to meet the Tier 4 Final emission standards • The facility operator of MM PRIMA DESHECHA ENERGY, LLC provided that a plan was submitted before 07/01/16, for the permanent shutdown of all subject equipment by 10/01/22 • Engines located at landfills or publicly owned treatment works that are subject to a NOx emission limit in a Regulation XI rule adopted/amended after 11/01/19
Requirements			
Non-Agricultural Operation IC Engines (ppmv @ *15% oxygen on a dry basis)*			
Rich-Burn	Waste Gas-Fueled	11	11
	Cyclic Loaded, Field Gas Fueled	11	No Such Category
	Limited Use	11	No Such Category
	Not Listed Above	11	11
Lean-Burn	Limited Use	11	No Such Category
	Used for Gas Compression	40, or 93% reduction	No Such Category
	Waste Gas-Fueled	40, or 90% reduction	11
	Not Listed Above	11	11

	SJVAPCD Rule 4702	SCAQMD Rule 1110.2
Agricultural Operation Spark-Ignited IC Engines (ppmv @ *15% oxygen on a dry basis)*		
Rich-Burn[141]	11, or 0.15 g/bhp-hr	11
Lean-Burn[142]	43, or 0.6 g/bhp-hr	11
Agricultural Operation Compression-Ignited IC Engines[143] (ppmv @ *15% oxygen on a dry basis)*		
	Tier 3 or Tier 4 Certified IC Engine	11, or Tier 4 Certified IC Engine

District Rule 4702 has similar limits compared to SCAQMD Rule 1110.2, and both rules have significantly lower emission limits than other California District rules. Notably, the SCAQMD's Regional Clean Air Incentives Market (RECLAIM) program currently exempts IC engines at RECLAIM facilities from the NOx emission limits of SCAQMD Rule 1110.2 until December 31, 2023. District Rule 4702 does not have similar exemptions to the rule requirements, therefore all operators are required to meet the stringent emission limitations included in Rule 4702. Therefore, District Rule 4702 is as stringent as or more stringent than SCAQMD Rule 1110.2.

Potential Emission Reduction Opportunities

Over the years, the District has adopted numerous generations of rules and rule amendments for engines that have significantly reduced NOx and VOC emissions from this source category. As part of these regulatory efforts, hundreds of engines in the Valley have been equipped with the best available NOx and VOC control technologies.

Most recently, in August 2021, the District Governing Board adopted amendments to Rule 4702 that included even more stringent emission limits for internal combustion engines operating in the Valley. Facilities are still in the process of complying with the most recent amendments by December 31, 2023, and December 31, 2029, depending on unit type. Therefore, the District did not identify additional emission reduction opportunities at this time.

Evaluation Findings

Rule 4702 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

[141] There are only 2 rich-burn spark ignited engines operating in SCAQMD per discussions with SCAQMD staff.
[142] There are no lean-burn spark ignited ag engines operating in SCAQMD per discussions with SCAQMD staff.
[143] Information from SCAQMD indicates that there are no stationary non-emergency diesel IC engines that operate in the SCAQMD.

2.18 RULE 4703 (STATIONARY GAS TURBINES)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	1.36	1.25	1.20	1.16	1.08	0.98	0.98
NOx	2.66	2.47	2.37	2.29	2.15	1.98	1.97
	Winter Average - Tons per day						
PM2.5	1.33	1.22	1.18	1.14	1.06	0.96	0.96
NOx	2.62	2.43	2.34	2.26	2.12	1.95	1.95

District Rule 4703 Description

District Rule 4703 limits NOx and CO emissions from stationary gas turbines with ratings equal to or greater than 0.3 MW or a maximum heat input of more than 3.0 MMBtu/hr. The main rule requirement is the limitation of NOx emissions. Laboratory units used in research and testing for the advancement of gas turbine technology, units limited by permit condition to be operated exclusively for firefighting and/or flood control, and emergency standby units limited by permit condition to operate less than 100 hours per calendar year for maintenance and testing purposes are not subject to the emission requirements of this rule.

How does District Rule 4703 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Techniques Guidelines applicable to this source category.

A. Alternative Control Techniques (ACT)

- *Alternative Control Techniques Document – NOx Emissions from Stationary Gas Turbines (EPA-453/R-93-007 1993/01)*

The District evaluated the requirements contained within the ACT for NOx Emissions from Stationary Gas Turbines and found no requirements that were more stringent than those already in Rule 4703.

B. New Source Performance Standards (NSPS)

- *40 CFR 60 Subpart GG – Standards of Performance for Stationary Gas Turbines (2009/03)*

The District evaluated the requirements contained within Subpart GG and found no emission requirements that were more stringent than those already in Rule 4703.

- *40 CFR 60 Subpart KKKK – Standards of Performance for Stationary Combustion Turbines*

The District evaluated the requirements contained within Subpart KKKK and found no emission requirements that were more stringent than those already in Rule 4703.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4703 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4703 to comparable requirements in rules from the following nonattainment areas:

- Bay Area AQMD Regulation 9, Rule 9 (Amended December 6, 2006)[144]
- Sacramento Metropolitan AQMD Rule 413 (Amended March 24, 2005)[145]
- San Diego County APCD Rule 69.3.1 (Adopted December 9, 2021)[146]
- South Coast AQMD Rule 1109.1 (Adopted November 5, 2021)[147]
- South Coast AQMD Rule 1134 (Amended February 4, 2022)[148]
- South Coast AQMD Rule 1135 (Amended January 7, 2022)[149]
- South Coast AQMD Rule 1150.3 (Adopted February 5, 2021)[150]

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[144] BAAQMD. *Regulation 9, Rule 9 (Nitrogen Oxides from Stationary Gas Turbines).* (Amended December 6, 2006). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-9-nitrogen-oxides-and-carbon-monoxide-from-stationary-gas-turbines/documents/rg0909.pdf?la=en&rev=fed388c23f264d6ebd5e6e40096bdf79
[145] SMAQMD. *Rule 413 (Stationary Gas Turbines).* (Amended March 24, 2005). Retrieved from: http://www.airquality.org/ProgramCoordination/Documents/rule413.pdf
[146] SDAPCD. *Rule 69.3.1 (Stationary Gas Turbine Engines)*. (Adopted December 9, 2021). Retrieved from: https://www.sdapcd.org/content/dam/sdapcd/documents/rules/current-rules/Rule-69.3.1.pdf
[147] SCAQMD. *Rule 1109.1 (Emissions of Oxides of Nitrogen from Petroleum Refineries and Related Operations).* (Adopted November 5, 2021). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/r1109-1.pdf?sfvrsn=8
[148] SCAQMD. *Rule 1134 (Emissions of Oxides of Nitrogen from Stationary Gas Turbines).* (Amended February 4, 2022). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1134.pdf?sfvrsn=4.
[149] SCAQMD. *Rule 1135 (Emissions of Oxides of Nitrogen from Electricity Generating Facilities).* (Amended January 7, 2022). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1135.pdf?sfvrsn=4
[150] SCAQMD. *Rule 1150.3 (Emissions of Oxides of Nitrogen from Combustion Equipment at Landfills)*. (Adopted February 5, 2021). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1150-3.pdf?sfvrsn=10

- South Coast AQMD Rule 1179.1 (Adopted October 2, 2020)[151]
- Ventura County APCD Rule 74.23 (Amended November 12, 2019)[152]

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4703 continues to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rules is demonstrated below.

San Diego County APCD

- SDAPCD Rule 69.3.1 (Stationary Gas Turbine Engines)

	SJVAPCD Rule 4703	SDAPCD Rule 69.3.1
Applicability	Gas turbines ≥0.3 MW or a maximum heat input rating of 3 MMBtu/hr.	Stationary gas turbines ≥0.3 MW or greater.
Exemptions	• Laboratory turbines used in research and testing for the advancement of gas turbine technology • Units limited by permit condition to be operated exclusively for firefighting and/or flood control • Emergency standby turbines limited by permit condition to operate <100 hr/yr for maintenance and testing	• Gas turbine engine when operated exclusively for research, development, or testing of gas turbine engines • Any portable gas turbine engine • Any stationary gas turbine engine with power rating ≤0.4 MW used in conjunction with military tactical support equipment operated at military site, provided operations do not exceed 1,000 hr/yr • NOx limits do not apply to any emergency unit provided that operation for testing or maintenance to ensure operability in event of an emergency situation is ≤80 hr/yr
	***NOx Emission Limits:** **Units Rated <3 MW** Gas Fuel - 9 ppmv Liquid Fuel - 25 ppmv **Units Rated ≥3 MW and <10 MW** *Pipeline Gas*: Steady State - 8 ppmv Non-Steady State - 12 ppmv Liquid Fuel - 25 ppmv *<877 hr/yr*: Gas Fuel - 9 ppmv Liquid Fuel - 25 ppmv *≥877 hr/yr and not listed above*: Gas Fuel - 5 ppmv Liquid Fuel - 25 ppmv	***NOx Emission Limits:** **Units Rated ≥0.3 and <2.9 MW** Gas Fuel - 42 ppmv Liquid Fuel - 65 ppmv **Units Rated ≥2.9 and <10 MW** Gas Fuel - 25 ppmv Liquid Fuel - 65 ppmv **Units Rated <4 MW Operating <877 hr/yr** Gas Fuel - 42 ppmv Liquid Fuel - 65 ppmv **Units Rated ≥*10 MW*** *Without installed post-combustion air pollution control equipment* Gas Fuel - 15 ppmv Liquid Fuel - 42 ppmv

[151] SCAQMD. *Rule 1179.1 (Emission Reductions from Combustion Equipment at Publicly Owned Treatment Works Facilities).* (Adopted October 2, 2020). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1179-1.pdf?sfvrsn=10
[152] VCAPCD. *Rule 74.23 (Stationary Gas Turbines).* (Amended November 12, 2019). Retrieved from: http://www.vcapcd.org/Rulebook/Reg4/RULE%2074.23.pdf

	SJVAPCD Rule 4703	SDAPCD Rule 69.3.1
	Units Rated ≥10 MW *Combined Cycle:* Gas Fuel - 5 ppmv (standard) Gas Fuel - 3 ppmv (enhanced) Liquid Fuel - 25 ppmv *Simple Cycle and ≥877 hr/yr:* Gas Fuel - 5 ppmv (standard) Gas Fuel - 3 ppmv (enhanced) Liquid Fuel - 25 ppmv *Simple Cycle and >200 hr/yr and <877 hr/yr:* Gas Fuel - 5 ppmv Liquid Fuel - 25 ppmv *Simple Cycle and ≤200 hr/yr:* Gas Fuel - 25 ppmv Liquid Fuel - 42 ppmv	*With installed post-combustion air pollution control equipment* Gas Fuel - 9 ppmv Liquid Fuel - 25 ppmv

*Referenced at 15% O2

The District evaluated the requirements contained within SDAPCD's Rule 69.3.1 and found no requirements that were more stringent than those already in Rule 4703. Therefore, District Rule 4703 is as stringent as or more stringent than SDAPCD Rule 69.3.1.

South Coast AQMD

- South Coast AQMD Rule 1109.1 (Emissions of Oxides of Nitrogen from Petroleum Refineries and Related Operations)

This rule includes limits for gas turbines operating at petroleum refineries. The District does not currently have any gas turbines operating at petroleum refineries.

- SCAQMD Rule 1134 (Emissions of Oxides of Nitrogen from Stationary Gas Turbines)

	SJVAPCD Rule 4703	SCAQMD Rule 1134
Applicability	Gas turbines rated ≥0.3 MW or with a maximum heat input rating of >3 MMBtu/hr.	Gas turbines rated ≥0.3 MW output or with a maximum heat input rating of >3 MMBtu/hr and operated on gaseous and/or liquid fuel.
Exemptions	• Laboratory turbines used in research and testing for the advancement of gas turbine technology • Units limited by permit condition to be operated exclusively for firefighting and/or flood control • Emergency standby turbines limited by permit condition to operate <100 hr/yr for maintenance and testing	• Laboratory turbines used in research and testing • Gas turbines used exclusively for firefighting and/or flood control • Emergency standby units used to provide electrical power, water pumping for flood control or firefighting, potable water pumping, or sewage pumping provided non-resettable engine hour requirement and operate <200 hr/yr • Gas turbines subject to SCAQMD rules for NOx emissions from electricity generating

<table>
<tr><th></th><th>SJVAPCD Rule 4703</th><th colspan="2">SCAQMD Rule 1134</th></tr>
<tr><td></td><td></td><td colspan="2">facilities; petroleum refineries and related operations, landfills, or publicly owned treatment works facilities
• Combined cycle gas turbines installed prior to 04/05/19 have conditional exemptions
• Low use installed prior to 04/05/19 have specific exemptions and subject to NOx limits at 12 ppmv</td></tr>
<tr><td rowspan="2">Requirements</td><td rowspan="2">*NOx Emission Limits:

Units Rated <3 MW
Gas Fuel - 9 ppmv
Liquid Fuel - 25 ppmv

Units Rated ≥3 MW and <10 MW
Pipeline Gas:
Steady State - 8 ppmv
Non-Steady State - 12 ppmv
Liquid Fuel - 25 ppmv

<877 hr/yr:
Gas Fuel - 9 ppmv
Liquid Fuel - 25 ppmv

≥877 hr/yr and not listed above:
Gas Fuel - 5 ppmv
Liquid Fuel - 25 ppmv

Units Rated ≥10 MW
Combined Cycle:
Gas Fuel - 5 ppmv (standard)
Gas Fuel - 3 ppmv (enhanced)
Liquid Fuel - 25 ppmv

Simple Cycle and ≥877 hr/yr:
Gas Fuel - 5 ppmv (standard)
Gas Fuel - 3 ppmv (enhanced)
Liquid Fuel - 25 ppmv

Simple Cycle and >200 hr/yr and <877 hr/yr:
Gas Fuel - 5 ppmv
Liquid Fuel - 25 ppmv

Simple Cycle and ≤200 hr/yr:
Gas Fuel - 25 ppmv
Liquid Fuel - 42 ppmv</td><td colspan="2">*NOx Emission Limits:</td></tr>
<tr><td>Current Limits:

Units Rated <2.9 MW
Gas Fuel - 25 ppmv

Units Rated ≥2.9 MW and <10 MW
No SCR
Gas Fuel - 15 ppmv
With SCR
Gas Fuel - 9 ppmv

Units Rated ≥10 MW
No SCR
Gas Fuel - 12 ppmv
With SCR
Gas Fuel - 9 ppmv</td><td>After Jan. 1, 2024:

Natural Gas – Combined Cycle/Cogeneration Turbine
2 ppmv

Natural Gas – Simple Cycle Turbine
2.5 ppmv

Produced Gas
9 ppmv

Other Gas Turbine
12.5 ppmv

Natural Gas – Compressor Gas Turbine
3.5 ppmv

Shall not burn liquid fuel in a stationary gas turbine except for:
• Those located in the Outer Continental Shelf (NOx limit of 30 ppmv)
• Those providing power for health facility during force majeure natural gas curtailment (no limit specified)</td></tr>
</table>

*Referenced at 15% O2

In EPA's evaluation of BACM/MSM for the *2018 PM2.5 Plan*,[153] District Rule 4703 requirements were compared to the current requirements in SCAQMD Rule 1134, and it

[153] EPA. *Technical Support Document, Evaluation of BACM/MSM, San Joaquin Valley PM2.5 Plan for the 2006 PM2.5 NAAQS.* (February 2020). Retrieved from: https://www.regulations.gov/document/EPA-R09-OAR-2019-0318-0005

was determined that Rule 4703 implemented BACM and MSM for this source category. The new limits in SCAQMD Rule 1134 have a compliance date of January 1, 2024, with a 12-month extension allowance to January 1, 2025 for some units, and thus are not yet achieved in practice. At this time, these limits have not been implemented anywhere in the nation and are beyond BACM.

- SCAQMD Rule 1135 (Emissions of Oxides of Nitrogen from Electricity Generating Facilities)

	SJVAPCD Rule 4703	SCAQMD Rule 1135
Applicability	Gas turbines rated ≥0.3 MW or with a maximum heat input rating of >3 MMBtu/hr.	Electric Generating Units at a facility owned or operated by an investor-owned electric utility or a publicly owned electric utility that has one or more electric generating units, or has electric generating units with a combined generation capacity ≥50 MW of electric power for distribution in the state or local electric grid system. Includes gas turbines with the exception of cogeneration units.
Exemptions	• Laboratory turbines used in research and testing for the advancement of gas turbine technology • Units limited by permit condition to be operated exclusively for firefighting and/or flood control • Emergency standby turbines limited by permit condition to operate <100 hr/yr for maintenance and testing	• Combined cycle gas turbines installed prior to 11/02/18 have conditional exemptions if they have a 2.5 ppmv permit limit for NOx as of 11/02/18 • Low use units installed prior 11/02/18 have conditional exemptions if they maintain an annual capacity factor below 25% in each calendar year and average calendar year capacity factor below 10% on a 3-year rolling basis
Requirements	***NOx Emission Limits:** **<u>Units Rated <3 MW</u>** Gas Fuel - 9 ppmv Liquid Fuel - 25 ppmv **<u>Units Rated ≥3 MW and <10 MW</u>** *<u>Pipeline Gas</u>:* Steady State - 8 ppmv Non-Steady State - 12 ppmv Liquid Fuel - 25 ppmv *<u><877 hr/yr</u>:* Gas Fuel - 9 ppmv Liquid Fuel - 25 ppmv *<u>≥877 hr/yr and not listed above</u>:* Gas Fuel - 5 ppmv Liquid Fuel - 25 ppmv **<u>Units Rated ≥10 MW</u>** *<u>Combined Cycle</u>:* Gas Fuel - 5 ppmv (standard) Gas Fuel - 3 ppmv (enhanced)	***NOx Emission Limits:** *Current Limits:* *<u>For Southern Cal Edison</u>* 0.15 lb/MWh *<u>For City of Glendale</u>* 0.20 lb/MWh *<u>For City of Burbank</u>* 0.20 lb/MWh *<u>For City of Pasadena</u>* 0.20 lb/MWh *After Jan. 1, 2024:* ***For units constructed after 11/02/18:*** *<u>Combined Cycle</u>:* Gas Fuel - 2 ppmv on 60 minute rolling average *<u>Simple Cycle</u>:* Gas Fuel - 2.5 ppmv on 60 minute rolling average ***For units where operator applied for initial ATC prior to 11/02/18:*** Same limits as above, with limited exceptions

	SJVAPCD Rule 4703	SCAQMD Rule 1135	
	Liquid Fuel - 25 ppmv *Simple Cycle and ≥877 hr/yr:* Gas Fuel - 5 ppmv (standard) Gas Fuel - 3 ppmv (enhanced) Liquid Fuel - 25 ppmv *Simple Cycle and >200 hr/yr and <877 hr/yr:* Gas Fuel - 5 ppmv Liquid Fuel - 25 ppmv *Simple Cycle and ≤200 hr/yr:* Gas Fuel - 25 ppmv Liquid Fuel - 42 ppmv		to be at 2.5 ppmv for combined cycle along with using the rolling average time requirements specified in the PTO on 11/02/18

*Referenced at 15% O2

Similar to the above discussion regarding SCAQMD Rule 1134, the new limits in SCAQMD Rule 1135 have a compliance date of January 1, 2024, and thus are not yet achieved in practice. At this time, these limits have not been implemented anywhere in the nation and are beyond BACM.

- South Coast AQMD Rule 1150.3 (Emissions of Oxides of Nitrogen from Combustion Equipment at Landfills

This rule includes limits for gas turbines operating at landfills. The District does not currently have any gas turbines operating at landfills.

- South Coast AQMD Rule 1179.1 (Emission Reductions from Combustion Equipment at Publicly Owned Treatment Works Facilities).

This rule includes limits for gas turbines operating at publicly owned treatment works facilities. The District does not currently have any permitted gas turbines operating at publicly owned treatment works facilities.

Ventura County APCD

- VCAPCD Rule 74.23 (Stationary Gas Turbines)

	SJVAPCD Rule 4703	VCAPCD Rule 74.23
Applicability	Gas turbines ≥0.3 MW or a maximum heat input rating of 3 MMBtu/hr.	Gas turbines ≥0.3 MW or greater.
Exemptions	• Laboratory turbines used in research and testing for the advancement of gas turbine technology • Units limited by permit condition to be operated exclusively for firefighting and/or flood control	• Laboratory units used in research and testing for the advancement of gas turbine technology • Units operated exclusively for firefighting and/or flood control • Units operated <200 hr/yr • Emergency standby units operating during either an emergency or maintenance operation. Maintenance operation is limited to 104 hr/yr

	SJVAPCD Rule 4703	VCAPCD Rule 74.23
	• Emergency standby turbines limited by permit condition to operate <100 hr/yr for maintenance and testing	
Requirements	***NOx Emission Limits:** **Units Rated <3 MW** Gas Fuel - 9 ppmv Liquid Fuel - 25 ppmv **Units Rated ≥3 MW and <10 MW** *Pipeline Gas:* Steady State - 8 ppmv Non-Steady State - 12 ppmv Liquid Fuel - 25 ppmv *<877 hr/yr:* Gas Fuel - 9 ppmv Liquid Fuel - 25 ppmv *≥877 hr/yr and not listed above:* Gas Fuel - 5 ppmv Liquid Fuel - 25 ppmv **Units Rated ≥10 MW** *Combined Cycle:* Gas Fuel - 5 ppmv (standard) Gas Fuel - 3 ppmv (enhanced) Liquid Fuel - 25 ppmv *Simple Cycle and ≥877 hr/yr:* Gas Fuel - 5 ppmv (standard) Gas Fuel - 3 ppmv (enhanced) Liquid Fuel - 25 ppmv *Simple Cycle and >200 hr/yr and <877 hr/yr:* Gas Fuel - 5 ppmv Liquid Fuel - 25 ppmv *Simple Cycle and ≤200 hr/yr:* Gas Fuel - 25 ppmv Liquid Fuel - 42 ppmv	***NOx Emission Limits:** *Current Limits:* **Units Rated <2.9 MW** Gas Fuel - 42 ppmv Liquid Fuel - 65 ppmv **Units Rated ≥2.9 MW and <10 MW** Gas Fuel - 42 ppmv Liquid Fuel - 65 ppmv **Units Rated ≥10 MW** *<877 hr/yr:* Gas Fuel - 42 ppmv Liquid Fuel - 65 ppmv *No SCR* Gas Fuel - 15 ppmv Liquid Fuel - 42 ppmv *With SCR* Gas Fuel - 9 ppmv Liquid Fuel - 25 ppmv *After Jan. 1, 2024:* Liquid Fuel - 30 ppmv Natural Gas - 2.5 ppmv Digester Gas - 9 ppmv Rule also includes a provision for alternative means of producing equivalent emission reductions at the facility site or in the community for units where compliance with the below limits would exceed the established cost effectiveness thresholds of the district.

*Referenced at 15% O2

VCAPCD amended Rule 74.23 in November 2019 to lower NOx emission limits; however, the limits do not take effect until January 1, 2024 and thus have not yet been demonstrated to be achieved in practice. Furthermore, VCAPCD's Rule 74.23 includes an alternative compliance option for facilities that exempts units from meeting the limits under certain conditions, including unfavorable cost effectiveness. At this time, these limits have not been implemented anywhere in the nation and are beyond BACM.

Potential Emission Reduction Opportunities

Beyond the review of current regulations and rule requirements, the District reviewed the feasibility of technologies and measures implemented in other regions and potential new technologies and measures that may be feasible for implementation in the near future.

NOx Emission Control Technologies

The District has adopted numerous rule amendments to Rule 4703 that have successfully and significantly reduced NOx emissions from this source category in the Valley. In an effort to identify potential emission NOx reduction opportunities, the District has evaluated the economic feasibility of requiring limits as low as 2 ppmv NOx @ 15% O2 for combined-cycle gas turbines and 2.5 ppmv NOx @ 15% O2 for simple cycle gas turbines.

SCR Systems

Most of the gas turbines in the San Joaquin Valley are already equipped with SCR systems to reduce NOx emissions. An SCR operates as an external control device where flue gases and ammonia reagent are passed through an appropriate catalyst. Ammonia, is injected upstream of the catalyst where it reacts and reduces NOx, over the catalyst bed, to form elemental nitrogen and other by-products. In simple-cycle turbines, SCR is placed downstream of dilution fan and oxidation catalyst (CO control device), whereas, in combined-cycle configuration, SCR is placed downstream of multiple pieces of equipment including duct burner, heat recovery steam generator (HRSG), oxidation catalyst, etc.

Typically there is enough room available in a simple cycle power plants to retrofit the unit with a modern SCR system capable of meeting 2.5 ppmv NOx without moving other components. In contrast, combined-cycle power plants are compact and will usually require system components to be moved in order to accommodate a modern SCR system capable of meeting 2.0 ppmv NOx.

To achieve NOx limits of 2 or 2.5 ppmv, an existing SCR system would either have to be expanded or replaced with a new modern SCR system. SCR system involves SCR housing, catalyst, ammonia injection system, ammonia flow monitor and control system, ammonia tanks, etc.

To be consistent with the existing categories in Table 5-3 of Rule 4703, the District has conducted cost effectiveness analyses to retrofit existing gas turbines with SCR systems for the following four scenarios:

1. Retrofit cost for a modern SCR system for units less than 3 MW unit to comply with 2 ppmvd NOx @ 15% O2*
2. Retrofit cost for a modern SCR system for units between 3 MW to 10 MW to comply with 2 ppmvd NOx @ 15% O2*

3. Retrofit cost of an SCR system for units greater than 10 MW simple cycle unit to comply with 2.5 ppmvd NOx @ 15% O2
4. Retrofit cost of an SCR system for units greater than 10 MW combined cycle to comply with 2 ppmvd NOx @ 15% O2

* Nearly all the permitted units rated less than 10 MW are cogeneration units. Therefore, the cost analyses for #1 and #4 above assume the turbine is a cogeneration unit.

Calculation Methodology

First, total annual cost is calculated using SCR retrofit cost for each category. Then, the potential NOx emission reduction for each turbine category is determined by taking the difference between the potential emissions and the emissions that could be reliably achievable by retrofitting the system with latest SCR technology capable of achieving 2.0 ppmv NOx @ 15% O2 for cogeneration turbines and 2.5 ppmv NOx @ 15% O2 for simple cycle turbines. Each unit is conservatively assumed to be operated for 8,760 hours per year at the maximum rated heat input capacity (MMBtu/hr).

NOx Reductions (tons/yr)
= (Current NOx Emission Factor – Potential NOx Emission Factor) ppmv (@ 15% O2) x 10^{-6} x 46 lb-NO2/lb-mol x 8,578 ft^3-exhaust/MMBtu x (20.95/(20.95 – 15)) x 1 lb-mol/379.5 ft^3-exhaust x Heat Input Rate (MMBtu/hr) x Operating Hours (hr/yr) x ton/2,000 lbs

Cost Effectiveness ($/ton)
= Total Annual Cost ($/yr) ÷ NOx Reductions (tons/yr)

1. Retrofit cost of units less than 3 MW unit with an SCR system capable of achieving 2 ppmv NOx @ 15% O2

Item	Value	Units/Source	Cost
Turbine Rating	2	MW	
SCR Cost/KW	475	$/kW, District facility*	
Operating Hours	8,760	hr/yr	
Direct Capital Costs			
Total Purchased Equip Cost (PEC)	$/kW x 1000 kW		$950,000
Freight	5% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$47,500
Sales Tax	8.25% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$78,375
Direct Installation Costs	25% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$237,500
Total Direct Capital Costs			$1,313,375
Indirect Capital Costs			
Facilities	5% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$47,500
Engineering	10% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$95,000

Item	Value	Units/Source	Cost
Process Contingency	5% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$47,500
Total Indirect Capital Costs			$190,000
Project Contingency	20% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$190,000
Total Capital Costs (TCC)	Direct Capital + Indirect Capital + Project Contingency		$1,693,375
Annualized Capital Costs (10 years @ 4% interest)	0.1233 TCC		$208,793
Direct Annual Costs			
Operating Costs			
Operator	0.5 hr/shift, $25/hr	OAQPS	$13,688
Supervisor	15% of operator cost	OAQPS	$2,053
Maintenance Costs			
Labor	0.5 hr/shift, $25/hr	OAQPS	$13,688
Materials	100% of labor cost	OAQPS	$13,688
Utility Costs			
Electricity Costs		not included	
Catalyst Replacement		not included	
Catalyst Disposal		not included	
Ammonia		not included	
NH3 Injection Skid		not included	
Total Direct Annual Costs			$43,116
Indirect Annual Costs			
Overhead	60% of operating and maintenance	OAQPS	$25,869
Administrative	2% PEC	OAQPS	$19,000
Insurance	1% PEC	OAQPS	$9,500
Property Tax	1% PEC	OAQPS	$9,500
Capital Recovery	0.13 x PEC (10% int. rate, 15 yr. period)	OAQPS	$123,500
Total Indirect Annual Costs			$187,369

Total Annual Costs	Annualized capital + Direct Annual + Indirect Annual		**$439,278**

**Per power consultant (Former SCR designer for John Zink), cost to retrofit is highly variable, ranging from $100 to $850 per kW. Large range because cost is highly dependent upon on how much equipment needs to be moved. Most units in valley are cogeneration units which would require equipment to be reconfigured. Thus, $475/kw average cost was chosen for the average retrofit.*

Cost Effectiveness Results

Type of Installation	Power Rating MW	Heat Input Rate MMBtu/hr	Current NOx Emission Factor (ppmvd @ 15% O2)	Potential NOx Emission Factor (ppmvd @ 15% O2)	NOx Reduction (tons/yr)	Total Annual Cost ($)	Cost Effectiveness ($/ton)
SCR system on a cogen system	2	30	9	2	1.26	$439,278	**$348,633.33**

2. Retrofit cost of an SCR system for units between 3 MW to 10 MW to comply with 2 ppmvd NOx @ 15% O2

Item	Value	Units/Source	Cost
Turbine Rating	3.5	MW	
SCR Cost/KW	475	$/kW, District facility*	
Operating Hours	8,760	hr/yr	
Direct Capital Costs			
Total Purchased Equip Cost (PEC)	$/kW x 1000 kW		$1,662,500
Freight	5% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$83,125
Sales Tax	8.25% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$137,156
Direct Installation Costs	25% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$415,625
Total Direct Capital Costs			$2,298,406
Indirect Capital Costs			
Facilities	5% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$83,125
Engineering	10% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$166,250
Process Contingency	5% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$83,125
Total Indirect Capital Costs			$332,500
Project Contingency	20% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$332,500
Total Capital Costs (TCC)	Direct Capital + Indirect Capital + Project Contingency		$2,963,406
Annualized Capital Costs (10 years @ 4% interest)	0.1233 TCC		$365,388
Direct Annual Costs			
Operating Costs			
Operator	0.5 hr/shift, $25/hr	OAQPS	$13,688
Supervisor	15% of operator cost	OAQPS	$2,053
Maintenance Costs			
Labor	0.5 hr/shift, $25/hr	OAQPS	$13,688
Materials	100% of labor cost	OAQPS	$13,688
Utility Costs			
Electricity Costs		not included	

Item	Value	Units/Source	Cost
Catalyst Replacement		not included	
Catalyst Disposal		not included	
Ammonia		not included	
NH3 Injection Skid		not included	
Total Direct Annual Costs			$43,116
Indirect Annual Costs			
Overhead	60% of operating and maintenance	OAQPS	$25,869
Administrative	2% PEC	OAQPS	$33,250
Insurance	1% PEC	OAQPS	$16,625
Property Tax	1% PEC	OAQPS	$16,625
Capital Recovery	0.13 x PEC (10% int. rate, 15 yr. period)	OAQPS	$216,125
Total Indirect Annual Costs			$308,494
Total Annual Costs	Annualized capital + Direct Annual + Indirect Annual		**$716,998**

**Per power consultant (Former SCR designer for John Zink), cost to retrofit is highly variable, ranging from $100 to $850 per kW. Large range because cost is highly dependent upon on how much equipment needs to be moved. Most units in valley are cogeneration units which would require equipment to be reconfigured. Thus, $475/kw average cost was chosen for the average retrofit.*

Cost Effectiveness Results

Type of Installation	Power Rating MW	Heat Input Rate MMBtu/hr	Current NOx Emission Factor (ppmvd @ 15% O2)	Potential NOx Emission Factor (ppmvd @ 15% O2)	NOx Reduction (tons/yr)	Total Annual Cost ($)	Cost Effectiveness ($/ton)
SCR system on a cogen system	3.5	51.7	5	2	0.93	$716,998	**$770,965.59**

3. Retrofit cost of an SCR system for units greater than 10 MW simple cycle unit to comply with 2.5 ppmvd NOx @ 15% O2

Item	Value	Units/Source	Cost
Turbine Rating	50	MW, Simple Cycle	
SCR Cost	4,100,000	From SCR Consultant*	
Operating Hours	8,760		
Direct Capital Costs			
Total Purchased Equip Cost (PEC)		See Above	$4,100,000
Freight	5% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$205,000
Sales Tax	8.25%PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$338,250
Direct Installation Costs	25% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$1,025,000
Total Direct Capital Costs			$5,668,250

Item	Value	Units/Source	Cost
Indirect Capital Costs			
Facilities	5% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$205,000
Engineering	10% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$410,000
Process Contingency	5% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$205,000
Total Indirect Capital Costs			$820,000
Project Contingency	20% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$820,000
Total Capital Costs (TCC)	Direct Capital + Indirect Capital + Project Contingency		$7,308,250
Annualized Capital Costs (10 years @ 4% interest)	0.1233 TCC		$901,107
Direct Annual Costs			
Operating Costs			
Operator	0.5 hr/shift, $25/hr	OAQPS	$13,688
Supervisor	15% of operator cost	OAQPS	$2,053
Maintenance Costs			
Labor	0.5 hr/shift, $25/hr	OAQPS	$13,688
Materials	100% of labor cost	OAQPS	$13,688
Utility Costs			
Electricity Costs		not included	$0
Cat Replacement, Ammonia Reagent, and Loss of Power from Backpressure		EPA Combustion Turbine NOx Technology Memo (Jan. 2022)	$70,000
Total Direct Annual Costs			$113,116
Indirect Annual Costs			
Overhead	60% of operating and maintenance	OAQPS	$25,869
Administrative	2% PEC	OAQPS	$82,000
Insurance	1% PEC	OAQPS	$41,000
Property Tax	1% PEC	OAQPS	$41,000
Capital Recovery	"0.13 x PEC		
(10% int. rate, 15 yr. period)"	OAQPS	$533,000	
Total Indirect Annual Costs			**$722,869**

Total Annual Costs	Annualized capital + Direct Annual + Indirect Annual		**$1,737,092**

**Per power consultant (Former SCR designer for John Zink), cost to retrofit is highly variable, ranging from $100 to $850 per kW. Large range because cost is highly dependent upon on how much equipment needs to be moved. Most units in valley are cogeneration units which would require equipment to be reconfigured. Thus, $475/kw average cost was chosen for the average retrofit.*

Cost Effectiveness Results

Type of Installation	Power Rating MW	Heat Input Rate MMBtu/hr	Current NOx Emission Factor (ppmvd @ 15% O2)	Potential NOx Emission Factor (ppmvd @ 15% O2)	NOx Reduction (tons/yr)	Total Annual Cost ($)	Cost Effectiveness ($/ton)
Retrofit - Simple Cycle	50	500	5	2.5	7.48	$1,737,092	**$232,231.55**

4. Retrofit cost of an SCR system for units greater than 10 MW combined cycle to comply with 2 ppmvd NOx @ 15% O2

Item	Value	Units/Source	Cost
Turbine Rating	90	MW, Simple Cycle	
SCR Cost	6,200,000	Combustion Turbine NOx Technology Memo (Jan. 2022)	
Operating Hours	8,760		
Direct Capital Costs			
Total Purchased Equip Cost (PEC)		See Above	$6,200,000
Freight	5% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$310,000
Sales Tax	8.25% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$511,500
Direct Installation Costs	25% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$1,550,000
Total Direct Capital Costs			$8,571,500
Indirect Capital Costs			
Facilities	5% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$310,000
Engineering	10% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$620,000
Process Contingency	5% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$310,000
Total Indirect Capital Costs			$1,240,000
Project Contingency	20% PEC	2015 Plan for the 1997 PM 2.5 Standard - Rule 4703 Control Measure Analysis	$1,240,000
Total Capital Costs (TCC)	Direct Capital + Indirect Capital + Project Contingency		$11,051,500
Annualized Capital Costs (10 years @ 4% interest)	0.1233 TCC		$1,362,650
Direct Annual Costs			
Operating Costs			
Operator	0.5 hr/shift, $25/hr	OAQPS	$13,688
Supervisor	15% of operator cost	OAQPS	$2,053
Maintenance Costs			
Labor	0.5 hr/shift, $25/hr	OAQPS	$13,688
Materials	100% of labor cost	OAQPS	$13,688
Utility Costs			
Electricity Costs		not included	$0

Item	Value	Units/Source	Cost
Cat Replacement, Ammonia Reagent, and Loss of Power from Backpressure		EPA Combustion Turbine NOx Technology Memo (Jan. 2022)	$300,000
Total Direct Annual Costs			$343,116
Indirect Annual Costs			
Overhead	60% of operating and maintenance	OAQPS	$25,869
Administrative	2% PEC	OAQPS	$124,000
Insurance	1% PEC	OAQPS	$62,000
Property Tax	1% PEC	OAQPS	$62,000
Capital Recovery	"0.13 x PEC		
(10% int. rate, 15 yr. period)"	OAQPS	$806,000	
Total Indirect Annual Costs			$1,079,869
Total Annual Costs	Annualized capital + Direct Annual + Indirect Annual		**$2,785,635**

**Per power consultant (Former SCR designer for John Zink), cost to retrofit is highly variable, ranging from $100 to $850 per kW. Large range because cost is highly dependent upon on how much equipment needs to be moved. Most units in valley are cogeneration units which would require equipment to be reconfigured. Thus, $475/kw average cost was chosen for the average retrofit.*

Cost Effectiveness Results

Type of Installation	Power Rating MW	Heat Input Rate MMBtu/hr	Current NOx Emission Factor (ppmvd @ 15% O2)	Potential NOx Emission Factor (ppmvd @ 15% O2)	NOx Reduction (tons/yr)	Total Annual Cost ($)	Cost Effectiveness ($/ton)
Retrofit - Combined Cycle	90	1,100	5	2	19.74	$2,785,635	**$141,116.26**

As demonstrated above, the District determined that the cost of achieving these lower NOx limits would result in a cost effectiveness ranging from $141,116.26/ton - $770,965.59/ton, depending on the specifications of the unit.

Based on this review, the District did not identify additional emission reduction opportunities for BACM at this time.

Evaluation Findings

Rule 4703 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.19 RULE 4901 (WOOD BURNING FIREPLACES AND WOOD BURNING HEATERS)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	2.82	2.58	2.53	2.53	2.53	2.53	2.53
NOx	0.42	0.38	0.38	0.38	0.38	0.38	0.38
	Winter Average - Tons per day						
PM2.5	5.47	5.02	4.92	4.92	4.92	4.92	4.92
NOx	0.81	0.74	0.73	0.73	0.73	0.73	0.73

District Rule 4901 Description

The District’s residential wood burning emission reduction strategy includes wood burning curtailments implemented through District Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters), in conjunction with the District’s incentive grant program for fireplace and woodstove change-outs, and robust public education and outreach efforts. This approach is designed to improve public health by reducing toxic wood smoke emissions in Valley neighborhoods during the peak PM2.5 winter season (November through February), and has proven to be extremely effective in advancing the District’s objectives to attain the PM2.5 federal standards and protect public health. Commitments in the District’s *2018 PM2.5 Plan* included rulemaking for Rule 4901 to further lower wood burning curtailment levels, as well as enhancements to the District’s incentive grant funding levels, public outreach and education, enforcement, and air quality forecasting programs.

Through the District’s Residential Wood Smoke Reduction Program, which is based on Rule 4901, the District has declared and enforced episodic wood burning curtailments, also called “No Burn” days, since 2003. The District’s Residential Wood Smoke Reduction Program and District Rule 4901 reduce harmful species of PM2.5 when and where those reductions are most needed, in impacted urbanized areas when the local weather is forecast to hamper particulate matter dispersion.

Rule 4901 was first adopted in 1993, and has been subsequently amended four times. The 1993 adoption of Rule 4901 established a public education program on techniques to reduce wood burning emissions. It also enforced EPA Phase II requirements for new wood burning heaters, prohibited the sale of used wood burning heaters, established a list of prohibited fuel types, and required the District to request voluntary curtailment of wood burning on days when the ambient air quality was unhealthy.

In 2003, the rule was amended and added episodic wood burning curtailments when air quality was forecast to be at 150 or higher on the air quality index (AQI), which was equivalent to a PM2.5 concentration of 65 µg/m³ at the time; added restrictions on the installation of wood burning devices in new residential developments, based on housing density; and added a requirement that during the transfer of a residential property, sellers provide a statement of compliance to the District and buyer for residential real properties with non-compliant wood burning devices.

In 2008, the rule was amended and lowered the mandatory curtailment level to a PM2.5 concentration of 30 µg/m^3, and added an attainment plan contingency measure that would lower the wood burning curtailment level to 20 µg/m^3 if EPA were to find that the Valley did not attain the 1997 PM2.5 NAAQS in 2014.

In 2014, Rule 4901 was amended again and lowered the No Burn threshold for high polluting wood burning heaters and fireplaces from 30 µg/m^3 to 20 µg/m^3 and raised the No Burn threshold for cleaner certified wood burning devices to 65 µg/m^3. The amendment doubled the number of No Burn days for high polluting units that were the source of over 95% of the wintertime residential wood smoke emissions.

In 2019, the District amended Rule 4901 to lower the curtailment threshold from 20 to 12 µg/m^3 for older, higher-polluting wood burning heaters, open hearth fireplaces, and non-registered wood burning heaters in the Hot Spot counties of Madera, Fresno, and Kern. Within these same Hot Spot counties, the cleaner, registered wood burning heaters are allowed to burn when air quality is forecast to be between 12 and 35 µg/m^3. In these counties, no wood burning is allowed when air quality is forecast to be above 35 µg/m^3. In the remaining Valley counties, the previous curtailment thresholds remain in place. The more stringent curtailment thresholds established in the Hot Spot counties are with increased *Fireplace and Woodstove Change-Out Program* incentives amounts to cover nearly the entire cost of replacing high polluting wood burning units with natural gas units. To complement the regulatory and incentives changes, the District has implemented an education and outreach campaign to increase public awareness of the program, along with focused rule enforcement efforts in Hot Spot counties and in areas of concern. The District also continues to investigate and employ the latest air quality modeling tools and techniques to support the air quality forecasting component of the program.

Following these amendments, EPA recognized in their February 2020 evaluation of BACM and MSM for the *2018 PM2.5 Plan* for the 2006 PM2.5 NAAQS that Rule 4901 implements BACM and MSM levels of control.[154] In July 2020, EPA took final action to approve the 2019 amendments to Rule 4901 and provide SIP credit for emissions reductions achieved through the strategy.[155]

Most recently, on May 18, 2023, the District amended Rule 4901 to establish a sequence of increasingly stringent contingency curtailment thresholds for all counties that would be triggered upon 60 days after the issuance of a final determination by EPA,

[154] EPA. *Technical Support Document, Evaluation of BACM/MSM, San Joaquin Valley PM2.5 Plan for the PM2.5 Plan for the 2006 PM2.5 NAAQS*. (February 2020). Retrieved from: https://www.regulations.gov/document/EPA-R09-OAR-2019-0318-0005

[155] EPA. *Air Plan Approval; California; San Joaquin Valley Unified Air Pollution Control District*. 85 FR 44206-44209. (July 22, 2020). Retrieved from: https://www.govinfo.gov/content/pkg/FR-2020-07-22/pdf/2020-14298.pdf

pursuant to 40 CFR §51.1014(a), that the District has failed to meet any of the following elements for any of the PM2.5 NAAQS to:

1. Meet any RFP requirement;
2. Meet any quantitative milestone in an approved attainment plan;
3. Submit a quantitative milestone report; or
4. Attain the applicable PM2.5 NAAQS by the applicable attainment date.

The following table depicts the sequence of increasingly stringent contingency curtailment thresholds to be enforced following each contingency trigger.

Table 2-10 District Contingency Curtailment Thresholds

Contingency Concept	Hot-Spot County (µg/m^3)		Non Hot-Spot County (µg/m^3)	
	Level 1	Level 2	Level 1	Level 2
Current Requirements	12	35	20	65
Contingency Measure 1	12	35	12	35
Contingency Measure 2	11	35	11	35

Hot-spot counties: Madera, Fresno, Kern
Non Hot-spot counties: San Joaquin, Stanislaus, Merced, Kings, Tulare

The contingency provisions, if triggered, would achieve 0.69 tpd of PM2.5 and 0.10 tpd NOx on an annual average basis, as calculated in the *PM2.5 Contingency Measure State Implementation Plan Revision*.[156]

Incentives and Outreach

The District's *Fireplace and Woodstove Change-Out Program* plays a key role in reducing emissions from residential wood burning by encouraging a transition from the use of higher polluting wood burning heaters and fireplaces to cleaner alternatives. Through the program, the District offers financial incentives for the change-out of old, high-polluting open-hearth fireplaces or uncertified devices with new cleaner, certified units. The program has provided the resources necessary for thousands of Valley resident to make positive changes in their residential wood-burning practices and is a significant part of the District's overall strategy to reduce the impacts of residential wood burning. The *Fireplace and Woodstove Change-Out Program* also continues to offer higher incentives for low-income households throughout the Valley (up to $4,150 for a new gas device, and up to $5,000 for an electric heat pump) to provide additional assistance towards the purchase of a new, cleaner unit. Since 2009, the District has issued over 28,000 vouchers with more than $57.6 million in program funding allocated to date.

To complement the regulatory and incentives changes, the District has implemented an education and outreach campaign to increase public awareness of the program, along with focused rule enforcement efforts in Hot Spot counties and in areas of concern. The

[156] SJVAPCD. *Proposed San Joaquin Valley Contingency Measure State Implementation Plan Revision.* (April 18, 2023). Retrieved from: https://www.valleyair.org/Workshops/postings/2023/05-18-23_r4901/proposed-sip.pdf?v=04.19.23

District also continues to investigate and employ the latest air quality modeling tools and techniques to support the air quality forecasting component of the program.

Residential Wood Burning Survey

Given the significant public health benefits that can be realized cost effectively from reductions in wood smoke emissions and to ensure continued effectiveness of the rule enhancements, on June 15, 2017, the District entered into a contract with Gomez Research to conduct a bilingual scientific survey in late 2017 to assess residential wood burning behaviors in the Valley.[157] Gomez Research surveyed over 1,500 Valley residents through an approach that consisted of both a general, random population of residents throughout the Valley as well as a supplemental sample, or “high-incidence area,” of 500 residents living in targeted zip codes believed to have higher concentrations of wood burning devices. Overall, the large survey response by Valley residents provides statistically significant results that can be relied upon to enhance our understanding of residential wood burning behavior in the San Joaquin Valley. The survey results, as detailed in the District’s Final Draft Staff Report from the 2018 rule amendments,[158] supported lowering the residential wood burning curtailment thresholds, coupled with enhanced public outreach and increased incentive amounts for the *Fireplace and Woodstove Change-Out Program*.

How does District Rule 4901 compare with federal and state rules and regulations?

There are no Control Techniques Guidelines or Alternative Control Techniques applicable to this source category.

A. New Source Performance Standards (NSPS)

- *40 CFR Part 60 Subpart AAA – Standards of Performance for New Residential Wood Heaters (2020/04)*

The District evaluated the requirements contained within Subpart AAA and found no emission requirements that were more stringent than those already in Rule 4901.

State Regulations

No California state regulations have been identified that are applicable to this source category. However, the District has identified regulations in other states that have wood burning requirements. These include the following regulations:

[157] Gomez Research. *Residential Wood Burning Survey*. (January 18, 2018). Retrieved from: http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2018/January/final/10.pdf
[158] SJVAPCD. *Final Draft Staff Report with Appendices for Proposed Amendments to District’s Residential Wood Burning Emission Reduction Strategy*, pp. 20-22. (June 20, 2019). Retrieved from: https://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2019/June/final/13.pdf

- ***Puget Sound Clean Air Agency (PSCAA) Regulation I, Article 13: Solid Fuel Burning Device Standards (Amended October 25, 2012)[159]***

	SJVAPCD Rule 4901	PSCAA Reg I, Article 13
Sole Source Exemption	Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence are not subject to level 1 and level 2 episodic wood burning curtailment requirements. This includes times of temporary service outages, as determined by the gas or electrical utility service.	A residence or commercial building that has no adequate source of heat other than a solid fuel heating device and the building: • was constructed or substantially remodeled after July 1, 1992; and • is outside an urban growth area; and • is outside an area designated as a PM2.5 or PM10 nonattainment area.
No Burn Day (Nov-Feb)	**<u>Level 1 Curtailment</u>** • For the counties of San Joaquin, Stanislaus, Merced, Kings, and Tulare, the APCO shall declare a Level 1 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to equal or exceed 20 µg/m³ but not exceed 65 µg/m³ for the geographic region. • For the counties of Madera, Fresno, and Kern, the APCO shall declare a Level 1 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to equal or exceed 12 µg/m³ but not exceed 35 µg/m³ for the geographic region. • Registered wood burning heater may be operated provided it's fired on approved fuel, maintained, and operated according to manufacturer instructions, and has no visible smoke. **<u>Level 2 Curtailment</u>** • For the counties of San Joaquin, Stanislaus, Merced, Kings, and Tulare, the APCO shall declare a Level 2 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to exceed 65 µg/m³ or a PM10 concentration is forecast to equal or exceed 135 µg/m³ for the geographic region. • For the counties of Madera, Fresno, and Kern, the APCO shall declare a Level 2 Episodic Wood Burning	No person in a residence or commercial establishment shall operate a solid fuel burning device under any of the following conditions: • Whenever the Agency has declared the first stage of impaired air quality for a geographical area. • New solid fuel shall be withheld from any solid fuel burning device already in operation for the duration of the first stage of impaired air quality if that device is restricted from operating. • Smoke visible from a chimney, flue, or exhaust duct after three hours has elapsed from the declaration of a first stage of impaired air quality shall constitute prima facie evidence of unlawful operation of a solid fuel burning device if that solid fuel burning device is restricted from operating during a first stage of impaired air quality. This presumption may be refuted by demonstration that the smoke was not caused by a solid fuel burning device. • Whenever the Agency has declared the **second stage** of impaired air quality for a geographical area. • New solid fuel shall be withheld from any solid fuel burning device already in operation for the duration of the second stage of impaired air quality if device is restricted from operating. • Smoke visible from a chimney, flue, or exhaust duct after three hours has elapsed from the declaration of a second stage of impaired air quality shall constitute prima facie evidence

[159] Puget Sound Clean Air Agency. *Regulation I, Article 13 (Solid Fuel Burning Device Standards).* (Amended October 25, 2012). Retrieved from: https://pscleanair.gov/DocumentCenter/View/161/Regulation-I-Section-1303-PDF?bidId

	SJVAPCD Rule 4901	PSCAA Reg I, Article 13
	Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to exceed 35 µg/m³ or a PM10 concentration is forecast to equal or exceed 135 µg/m³ for the geographic region.	of unlawful operation of a solid fuel burning device if that solid fuel burning device is restricted from operating during a second stage of impaired air quality. This presumption may be refuted by demonstration that the smoke was not caused by a solid fuel burning device.

Sale, Resale, or Installation of Wood-Burning Devices	Sale or transfer of wood burning heaters:
	• New: No person shall advertise, sell, offer for sale, supply, install, or transfer a new wood burning heater unless it is either EPA certified under the NSPS at the time of purchase or installation and at least as stringent as EPA Phase II requirements, or a pellet-fueled wood burning heater that is exempt from EPA certification pursuant to requirements in the NSPS, until such time that amendments to the NSPS are finalized to remove exemptions for pellet-fueled wood burning heaters, then all new wood burning heaters must comply with the above.
	• Used: No person shall advertise, sell, offer for sale, supply, install, or transfer a used wood burning heater unless it has been rendered permanently inoperable, satisfies NSPS, or is a low mass fireplace, masonry heater, or other wood burning device of a make and model that meets all federal requirements and has been approved in writing by the APCO.
	
	Limitations on wood burning fireplaces or wood burning heaters
	• At elevations below 3,000 feet in areas with natural gas service, no person shall install a wood burning fireplace, low mass fireplace, masonry heater, or wood burning heater.
	• At elevations at or above 3,000 feet or in areas without natural gas service, no more than two EPA certified wood burning heaters, that meet NSPS at time of installation, shall be installed per acre.
	  ○ No person shall install more than one EPA certified wood burning heater, that meets NSPS at time of installation, per dwelling unit.
		A person shall not advertise to sell, offer to sell, sell, bargain, exchange, give away, or install a solid fuel burning device unless it meets both of the following:
		• It has been certified and labeled in accordance with procedures and criteria specified in "40 CFR 60 Subpart AAA - Standards of 12/12 13-7 Regulation I Performance for Residential Wood Heaters" as amended through July 1, 1990; and
		• It meets the following particulate air contaminant emission standards and the test methodology of EPA in effect on Jan. 1, 1991, or an equivalent standard under any test methodology adopted by EPA subsequent to such date:
		  ○ Two and one-half grams per hour for catalytic woodstoves; and
		  ○ Four and one-half grams per hour for all other solid fuel burning devices.
		
		Fireplaces. A person shall not advertise to sell, offer to sell, sell, bargain, exchange, give away, or install a factory-built fireplace unless it meets the 1990 EPA standards for wood stoves or an equivalent standard that may be established by the state building code council by rule.

	SJVAPCD Rule 4901	PSCAA Reg I, Article 13
	○ No person shall install a wood burning fireplace, low mass fireplace, masonry heater, or non-certified wood burning heater.	
Requirements for Non-Certified Units	Rule requires only EPA certified units be sold in the area.	Any person who owns or is responsible for a wood stove that is both (a) not a certified wood stove and (b) is located in the Tacoma, Washington PM2.5 nonattainment area must remove and dispose of it or render it permanently inoperable by Sept. 30, 2015. Any person who owns or is responsible for a coal-only heater located in the Tacoma, Washington fine particulate nonattainment area must remove and dispose of it or render it permanently inoperable by Sept. 30, 2015. Removal and disposal requirements for non-certified wood stoves located in the Tacoma, Washington PM2.5 nonattainment area do not apply to: • A person in a residence or commercial establishment that does not have an adequate source of heat without burning wood; or • A person with a shop or garage that is detached from the main residence or commercial establishment that does not have an adequate source of heat in the detached shop or garage without burning wood. The owner or person responsible for removing or rendering permanently inoperable a wood stove or a coal-only heater must provide documentation of the removal and disposal or rendering permanently inoperable to the Agency using the Agency's procedures within 30 days of the removal or rendering permanently inoperable. If the EPA makes written findings below, the use of wood stoves not meeting the standards set forth in the emission performance standards for solid fuel burning devices shall be prohibited within the area determined by the Agency to have contributed to the violation. This provision shall take effect one year after such a determination. • An area has failed to attain or maintain the NAAQS for PM10, and

	SJVAPCD Rule 4901	PSCAA Reg I, Article 13
		• In consultation with Ecology and the Agency, finds that the emissions from solid fuel burning devices are a contributing factor to such failure to attain or maintain the standard
Visible Emissions	• Under normal operating conditions, no person shall cause or allow any visible smoke from a registered wood burning heater. • Under normal operating conditions, no person shall cause or allow from a wood burning fireplace or nonregistered wood burning heater a visible emission of any air contaminant, other than uncombined water vapor, that exceeds No. 1 on the Ringelmann Chart or 20% opacity for a period or periods aggregating more than 3 minutes in any 1 hour.	A person shall not cause or allow emission of a smoke plume from any solid fuel burning device to exceed an average of 20% opacity for 6 consecutive minutes in any 1-hour period.
Prohibited Fuels	No person shall cause or allow any of the following materials to be burned in a wood burning fireplace, wood burning heater, or outdoor wood burning device: garbage, treated wood, non-seasoned wood, plastic products, rubber products, waste petroleum products, paints and paint solvents, coal, or any other material not intended by a manufacturer for use as a fuel in a wood burning fireplace, wood burning heater, or outdoor wood burning device.	A person shall cause or allow only the following materials to be burned in a solid fuel burning device: • Properly seasoned fuel wood; or • An amount of paper necessary for starting a fire; or • Wood pellets; or • Biomass fire logs intended for burning in wood stove or fireplace; or • Coal with sulfur content <1.0% by weight burned in a coal-only heater. All other materials are prohibited from being burned.

The District evaluated the requirements contained within Puget Sound Clean Air Agency Article 13 and found that District Rule 4901 is more stringent.

- ***Albuquerque City Ordinance § 9-5***

	SJVAPCD Rule 4901	Albuquerque City Ordinance § 9-5
EPA Certified Exemption	EPA certified units are not exempt from rule requirements.	Certified heaters may be operated during a no burn period provided that no visible emissions are produced beyond a 20-minute startup period.
Sole Source Exemption	Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence are not subject to level 1 and level 2 episodic wood burning curtailment requirements. This includes times of temporary service outages, as determined by the gas or electrical utility service.	• If wood burning device is the sole source of heat • Medical necessity of a wood burning device • Low income status

	SJVAPCD Rule 4901	Albuquerque City Ordinance § 9-5
Limited Exemption: Loss of NG and/or Electrical Power	Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence are not subject to level 1 and level 2 episodic wood burning curtailment requirements. This includes times of temporary service outages, as determined by the gas or electrical utility service.	Emergency situations such as failure of residence's primary heating system.
Wood Burning Season	November through February	October through February
No Burn Day	**Level 1 Curtailment** • For the counties of San Joaquin, Stanislaus, Merced, Kings, and Tulare, the APCO shall declare a Level 1 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to equal or exceed 20 µg/m³ but not exceed 65 µg/m³ for the geographic region. • For the counties of Madera, Fresno, and Kern, the APCO shall declare a Level 1 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to equal or exceed 12 µg/m³ but not exceed 35 µg/m³ for the geographic region. • Registered wood burning heater may be operated provided it's fired on approved fuel, maintained, and operated according to manufacturer instructions, and has no visible smoke. **Level 2 Curtailment** • For the counties of San Joaquin, Stanislaus, Merced, Kings, and Tulare, the APCO shall declare a Level 2 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to exceed 65 µg/m³ or a PM10 concentration is forecast to equal or exceed 135 µg/m³ for the geographic region. • For the counties of Madera, Fresno, and Kern, the APCO shall declare a Level 2 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to exceed 35 µg/m³ or a PM10 concentration is forecast to equal or exceed 135 µg/m³ for the geographic region.	No burn periods shall be declared by the Director upon review of available meteorological data and a determination that expected atmospheric conditions will not reasonably disperse wood smoke.

	SJVAPCD Rule 4901	Albuquerque City Ordinance § 9-5
Visible Emissions	• Under normal operating conditions, no person shall cause or allow any visible smoke from a registered wood burning heater. • Under normal operating conditions, no person shall cause or allow from a wood burning fireplace or nonregistered wood burning heater a visible emission of any air contaminant, other than uncombined water vapor, that exceeds No. 1 on the Ringelmann Chart or 20% opacity for a period or periods aggregating more than 3 minutes in any one (1) hour.	Certified wood heaters may be operated during a no burn period provided that no visible emissions are produced beyond a 20-minute start up period.

The District evaluated the requirements contained within Albuquerque City Ordinance §9-5 and found that District Rule 4901 is as stringent as or more stringent than the ordinance.

How does District Rule 4901 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4901 to comparable requirements in rules from the following nonattainment areas:

- South Coast AQMD Rule 445 (Amended October 27, 2020)[160]
- Sacramento Metropolitan AQMD Rule 417 (Adopted October 26, 2006)[161]
- Sacramento Metropolitan AQMD Rule 421 (Amended September 24, 2009)[162]
- Bay Area AQMD Regulation 6, Rule 3 (Amended November 20, 2019)[163]

Ventura County APCD does not have an analogous rule for this source category.

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4901 continues to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rules is demonstrated below.

[160] SCAQMD. *Rule 445 (Wood-Burning Devices).* (Amended October 27, 2020). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/rule-iv/rule-445.pdf?sfvrsn=4
[161] SMAQMD. *Rule 417 (Wood Burning Appliances).* (Adopted October 26, 2006). Retrieved from: https://www.airquality.org/ProgramCoordination/Documents/rule417.pdf
[162] SMAQMD. *Rule 421 (Mandatory Episodic Curtailment of Wood and Other Solid Fuel Burning).* (Amended September 24, 2009). Retrieved from: https://www.airquality.org/ProgramCoordination/Documents/rule421.pdf
[163] BAAQMD. *Regulation 6, Rule 3 (Wood-Burning Devices).* (Amended November 20, 2019). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/regulation-6-rule-3/documents/20191120_r0603_final-pdf.pdf?la=en&rev=cbb545815c15468cb98f8c1b23c083d2

South Coast AQMD

- SCAQMD Rule 445 (Wood Burning Devices)

	SJVAPCD Rule 4901	SCAQMD Rule 445
Applicability	• Any person who manufactures, sells, offers for sale, or operates a wood burning fireplace, wood burning heater, or outdoor wood burning device. • Any person who sells, offers for sale, or supplies wood intended for burning in a wood burning fireplace or wood burning heater. • Any person who sells or transfers a real property. • Any person who installs a wood burning fireplace or wood burning heater.	• Any person that manufacturers, sells, offers for sale, or installs a wood-burning device. • Any commercial firewood seller that sells, offers for sale, or supplies wood or other wood-based fuels intended for burning in a wood-burning-device or portable outdoor wood-burning device. • Any property owner or tenant that operates a wood-burning device or portable outdoor wood-burning device.
General Exemptions	• Devices that are exclusively gaseous-fueled. • Cook stoves, as described in 40 CFR §60.531. • Any burning occurring on the ground is open burning and is subject to requirements of District Rule 4103.	• Wood-fired cooking devices designed and used for commercial purposes. • The provisions for new or used permanently installed indoor or outdoor wood-burning devises or gaseous-fueled devices shall not apply to an indoor or outdoor wood-burning device that is permanently installed and included in the sale or transfer of any existing development. • The provisions for new or used permanently installed indoor or outdoor wood-burning devises or gaseous-fueled devices shall not apply to properties that are registered as a historical site, or are contributing structures located in a Historic Preservation Overlay Zone, as determined by the applicable, federal, State, or local agency. Contributing structures are those buildings which are examples of the predominate styles of the area, built during the time period when the bulk of the structures were built in the Historic Preservation Overlay Zone. • The no burn provisions for any product not intended for use as fuel in a wood-burning device shall not apply to manufactured firelogs. • The labeling and sell-through provision shall not apply to wood-based fuel intended for the cooking, smoking, or flavoring of food. • The provisions of the wood-burning season PM2.5 mandatory burning curtailment, PM2.5 contingency

	SJVAPCD Rule 4901	SCAQMD Rule 445
		measures, and ozone contingency measures shall not apply under the following circumstances: ○ Residential or commercial properties where a wood-burning device is the sole source of heat; or ○ A low income household; or ○ Residential or commercial properties where there is no existing infrastructure for natural gas service within 150 feet of property line; or ○ Residential or commercial properties located 3,000 or more feet above mean sea level; or ○ Ceremonial fires exempted under Rule 444 (Open Burning).
Natural Gas Exemption	Locations where natural gas is not available are not subject to episodic curtailments (propane and butane are not considered natural gas).	Installation requirements for new developments shall not apply to new developments where there is no existing infrastructure for natural gas service within 150 feet of the property line or those 3,000 or more feet above mean sea level.
Sole Source Exemption	Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence are not subject to level 1 and level 2 episodic wood burning curtailment requirements. This includes times of temporary service outages, as determined by the gas or electrical utility service.	The provisions of the wood-burning season PM2.5 mandatory burning curtailment, PM2.5 contingency measures, and ozone contingency measures shall not apply to residential or commercial properties where a wood-burning device is the sole source of heat.
No Burn Day (Nov-Feb)	**<u>Level 1 Curtailment</u>** • For the counties of San Joaquin, Stanislaus, Merced, Kings, and Tulare, the APCO shall declare a Level 1 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to equal or exceed 20 µg/m³ but not exceed 65 µg/m³ for the geographic region. • For the counties of Madera, Fresno, and Kern, the APCO shall declare a Level 1 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to equal or exceed 12 µg/m³ but not exceed 35 µg/m³ for the geographic region. • Registered wood burning heater may be operated provided it's fired on approved fuel, maintained, and operated according to manufacturer	No person shall operate an indoor or outdoor wood-burning device, portable outdoor wood-burning device, or wood-fired cooking device on a calendar day during the wood-burning season for PM2.5 so declared to the public by the Executive Officer to be a mandatory wood-burning curtailment (No-Burn) day based on the specified geographic area below 3,000 feet above mean sea level and applicable daily PM2.5 air quality forecast as follows: • Basin-wide if the daily PM2.5 air quality forecast for any source receptor area exceeds 30 µg/m³, or • Subsequent to a determination by U.S. EPA, pursuant to 40 CFR §51.1014(a) of a failure to comply with either a referenced PM2.5 standard or reporting requirement; the applicable daily PM2.5 air quality forecast as set

	SJVAPCD Rule 4901	SCAQMD Rule 445
	instructions, and has no visible smoke. **<u>Level 2 Curtailment</u>** • For the counties of San Joaquin, Stanislaus, Merced, Kings, and Tulare, the APCO shall declare a Level 2 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to exceed 65 µg/m³ or a PM10 concentration is forecast to equal or exceed 135 µg/m³ for the geographic region. • For the counties of Madera, Fresno, and Kern, the APCO shall declare a Level 2 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to exceed 35 µg/m³ or a PM10 concentration is forecast to equal or exceed 135 µg/m³ for the geographic region.	forth in the PM2.5 Contingency Measures requirements. Prohibitions on Permissive Burn Days or restrictions on Marginal Burn Days shall be in effect only if a No-Burn day is declared during any of the consecutive months of November, December, January, or February.
Sale, Resale, or Installation of Wood-Burning Devices	Sale or transfer of wood burning heaters: • New: No person shall advertise, sell, offer for sale, supply, install, or transfer a new wood burning heater unless it is either EPA certified under the NSPS at the time of purchase or installation and at least as stringent as EPA Phase II requirements, or a pellet-fueled wood burning heater that is exempt from EPA certification pursuant to requirements in the NSPS, until such time that amendments to the NSPS are finalized to remove exemptions for pellet-fueled wood burning heaters, then all new wood burning heaters must comply with the above. • Used: No person shall advertise, sell, offer for sale, supply, install, or transfer a used wood burning heater unless it has been rendered permanently inoperable, satisfies NSPS, or is a low mass fireplace, masonry heater, or other wood burning device of a make and model that meets all federal requirements and has been approved in writing by the APCO.	• No person shall sell, offer for sale, supply, or install, a new or used permanently installed indoor or outdoor wood-burning device or gaseous-fueled device unless it is one of the following: ○ EPA Certified wood-burning heater; or ○ Pellet-fueled wood-burning heater; or ○ A masonry heater; or ○ A dedicated gaseous-fueled fireplace
Requirements for Real Property	No person shall sell or transfer any real property which contains a wood burning heater without first assuring that each	EPA certification requirements do not apply to:

	SJVAPCD Rule 4901	SCAQMD Rule 445
	wood burning heater included in the real property: • Meets certification under the NSPS at the time of purchase or installation and is at least as stringent as EPA Phase II requirements, • Is a pellet-fueled wood burning heater that was exempt from EPA certification pursuant to requirements in the NSPS at the time of purchase or installation, or • Is rendered permanently inoperable and removed from property. Upon the sale or transfer of any residential real property in the San Joaquin Valley, the seller shall provide to the buyer of the real property and to the APCO, documentation certifying the following: • The type(s) and number(s) of wood burning heaters and wood burning fireplaces included in the real property transaction. If no wood burning heaters or wood burning fireplaces are included in the real property transaction, this should be documented. • Any action(s) taken to comply with the above requirements for sale or transfer of real property. • Documents required shall be retained by the seller and shall again be made available to the APCO upon request.	• Indoor or outdoor wood-burning device that is permanently installed and included in the sale or transfer of any existing development. • Properties that are registered as a historical site, or are contributing structures located in a Historic Preservation Overlay Zone, as determined by the applicable, federal, State, or local agency. Contributing structures are those buildings which are examples of the predominate styles of the area, built during the time period when the bulk of the structures were built in the Historic Preservation Overlay Zone.
Requirements for Remodels	Remodel of wood burning fireplace or chimney where total cost exceeds $15,000, local building permit is required, and application for building permit is submitted on or after Jan. 1, 2020: • A person may only install a gas-fueled, electric, exempt, or EPA certified wood burning heater that meets requirements of NSPS at the time of installation.	None.
Requirements for Buildings	Limitations on wood burning fireplaces or wood burning heaters • At elevations below 3,000 feet in areas with natural gas service, no person shall install a wood burning fireplace, low mass fireplace, masonry heater, or wood burning heater. • At elevations at or above 3,000 feet or in areas without natural gas service, no more than two EPA certified wood	No person shall permanently install a wood-burning device into any new development.

	SJVAPCD Rule 4901	SCAQMD Rule 445
	burning heaters, that meet NSPS at time of installation, shall be installed per acre. ○ No person shall install more than one EPA certified wood burning heater, that meets NSPS at time of installation, per dwelling unit. ○ No person shall install a wood burning fireplace, low mass fireplace, masonry heater, or non-certified wood burning heater.	
Solid Wood Fuel or Wood Sale	Advertising Requirements for Sale of Wood • No person shall sell, offer for sale, or supply any wood which is orally or in writing, advertised, described, or in any way represented to be “seasoned wood” unless the wood has a moisture content of ≤20% by weight. • The APCO may delegate another person or agency the authority to test wood for moisture content and determine compliance.	• A commercial firewood seller shall only sell seasoned wood from July 1 through the end of February the following year. Any commercial firewood seller may sell seasoned as well as non-seasoned wood during the remaining months. • No commercial firewood seller shall sell, offer for sale, or supply wood-based fuel without first attaching a permanently affixed indelible label to each package or providing written notice to each buyer at the time of purchase of bulk firewood that at a minimum states the following: “Use of this and other solid fuel products may be restricted at times by law. Please check (1-877-4NO-Burn) or (www.8774NOBURN.org) before burning.” Labeling requirements do not apply to wood-based fuel intended for cooking, smoking, or flavoring of food. The Executive Officer shall specify guidelines for the aforementioned labeling requirements.
Prohibited Fuels	No person shall cause or allow any of the following materials to be burned in a wood burning fireplace, wood burning heater, or outdoor wood burning device: garbage, treated wood, non-seasoned wood, plastic products, rubber products, waste petroleum products, paints and paint solvents, coal, or any other material not intended by a manufacturer for use as a fuel in a wood burning fireplace, wood burning heater, or outdoor wood burning device.	No person shall burn any product not intended for use as fuel in a wood-burning device including, but not limited to, garbage, treated wood, particle board, plastic products, rubber products, waste petroleum products, paints, coatings or solvents, or coal. Manufactured logs are exempt from this requirement.

The District evaluated the requirements contained within SCAQMD Rule 445 and found that overall District Rule 4901 is as stringent as or more stringent than SCAQMD Rule 445.

Bay Area AQMD

- BAAQMD Regulation 6, Rule 3 (Wood-Burning Devices)

	SJVAPCD Rule 4901	BAAQMD Reg 6, Rule 3
Natural Gas Exemption	Locations where natural gas is not available are not subject to episodic curtailments (propane and butane are not considered natural gas).	No exemption.
Sole Source Exemption	Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence are not subject to level 1 and level 2 episodic wood burning curtailment requirements. This includes times of temporary service outages, as determined by the gas or electrical utility service.	Any person whose sole source of heat is an EPA certified wood-burning device that is registered with the District per the requirements for registration of EPA certified wood heaters and registration renewal and who does not have available to them a permanently-installed NG, propane, or electric heating device. Any person seeking this exemption under must have previously registered their EPA certified wood heater in the District's registration program and must maintain documentation that the device is operated according to manufacturer's specifications. The following wood heaters are eligible to registered: • Wood heaters that are EPA certified to meet performance and emission standards of 7.5 g/hr or less • A pellet-fueled wood heater exempt from EPA certification requirements pursuant to 40 CFR 60 AAA at the time of purchase or installation
Limited Exemption: Loss of NG and/or Electrical Power	Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence. This includes times of temporary service outages, as determined by the gas or electrical utility service are exempt from wood burning curtailments.	Mandatory burn bans shall not apply to a person whose dwelling is in an area that has a temporary loss of gas and/or electric utility service and there is no alternate form of heat available. Qualification for exemption is subject to verification.
Limited Exemption: Non- Functional Permanently Installed Heater	Those for whom a wood burning fireplace or wood burning heater is the sole available source of heat in a residence are not subject to level 1 and level 2 episodic wood burning curtailment requirements. This includes times of temporary service outages, as determined by the gas or electrical utility service.	Mandatory burn bans do not apply to any person whose only non-wood burning, permanently installed source of heat is non-functional and requires repair to resume operations. A dwelling may qualify for a 30-day exemption if there is no alternate form of heat and the non-functional heater is repaired to resume function within 30 days. Qualification for this exemption is subject to verification and must be supported by documentation of repair, which must be submitted to the District within 10 days of a receipt of a request for such records.

	SJVAPCD Rule 4901	BAAQMD Reg 6, Rule 3
No Burn Day (Nov-Feb)	**Level 1 Curtailment** • For the counties of San Joaquin, Stanislaus, Merced, Kings, and Tulare, the APCO shall declare a Level 1 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to equal or exceed 20 µg/m^3 but not exceed 65 µg/m^3 for the geographic region. • For the counties of Madera, Fresno, and Kern, the APCO shall declare a Level 1 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to equal or exceed 12 µg/m^3 but not exceed 35 µg/m^3 for the geographic region. • Registered wood burning heater may be operated provided it's fired on approved fuel, maintained, and operated according to manufacturer instructions, and has no visible smoke.	Any period during which the air quality is forecast by the District to be unhealthy due to ambient levels of particulate matter exceeding 35 µg/m^3 and burning wood or any solid fuels is illegal in the Bay Area. A Mandatory Burn Ban is announced through a Spare the Air Alert. • No person shall operate or combust wood or solid-fuel products in any wood-burning device during a Mandatory Burn Ban.
	Level 2 Curtailment • For the counties of San Joaquin, Stanislaus, Merced, Kings, and Tulare, the APCO shall declare a Level 2 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to exceed 65 µg/m^3 or a PM10 concentration is forecast to equal or exceed 135 µg/m^3 for the geographic region. • For the counties of Madera, Fresno, and Kern, the APCO shall declare a Level 2 Episodic Wood Burning Curtailment for a geographic region whenever the potential for a PM2.5 concentration is forecast to exceed 35 µg/m^3 or a PM10 concentration is forecast to equal or exceed 135 µg/m^3 for the geographic region.	
Wood Heater Manufacturers & Retailers	Sale or transfer of wood burning heaters: • New: No person shall advertise, sell, offer for sale, supply, install, or transfer a new wood burning heater unless it is either EPA certified under the NSPS at the time of purchase or installation and at least as stringent as EPA Phase II requirements, or a	No manufacturer or retailer shall advertise, sell, offer for sale or resale, supply, install or transfer a new or used wood-burning device unless the device meets or exceeds 40 CFR 60 AAA • Any wood heater that is manufactured or sold at retail must meet an emissions rating of 2.5 g/hr if crib tested, or 2.0 g/hr if cordwood tested

	SJVAPCD Rule 4901	BAAQMD Reg 6, Rule 3
Sale, Resale, or Installation of Wood-Burning Devices	pellet-fueled wood burning heater that is exempt from EPA certification pursuant to requirements in the NSPS, until such time that amendments to the NSPS are finalized to remove exemptions for pellet-fueled wood burning heaters, then all new wood burning heaters must comply with the above. • Used: No person shall advertise, sell, offer for sale, supply, install, or transfer a used wood burning heater unless it has been rendered permanently inoperable, satisfies NSPS, or is a low mass fireplace, masonry heater, or other wood burning device of a make and model that meets all federal requirements and has been approved in writing by the APCO.	No person shall advertise, sell, offer for sale or resale, supply, install or transfer a new or used wood-burning device unless it meets 60 CFR 60 AAA. This requirement does not apply if a wood-burning device is an installed fixture in the sale or transfer of any real property.

	SJVAPCD Rule 4901	BAAQMD Reg 6, Rule 3
Requirements for Real Property	No person shall sell or transfer any real property which contains a wood burning heater without first assuring that each wood burning heater included in the real property: • Meets certification under the NSPS at the time of purchase or installation and is at least as stringent as EPA Phase II requirements, • Is a pellet-fueled wood burning heater that was exempt from EPA certification pursuant to requirements in the NSPS at the time of purchase or installation, or • Is rendered permanently inoperable and removed from property. Upon the sale or transfer of any residential real property in the San Joaquin Valley, the seller shall provide to the buyer of the real property and to the APCO, documentation certifying the following: • The type(s) and number(s) of wood burning heaters and wood burning fireplaces included in the real property transaction. If no wood burning heaters or wood burning fireplaces are included in the real property transaction, this should be documented. • Any action(s) taken to comply with the above requirements for sale or transfer of real property • Documents required shall be retained by the seller and shall again be made available to the APCO upon request.	Any person selling, renting or leasing a real property shall provide sale or rental disclosure documents that describe the health hazards of PM2.5 (in accordance with BAAQMD guidance) from burning wood or any solid fuel as a source.
Requirements for Rental Properties	None.	All real property offered for lease or rent in areas with natural gas service shall have a permanently-installed form of heat that does not burn solid fuel.

	SJVAPCD Rule 4901	BAAQMD Reg 6, Rule 3
Requirements for Buildings	Limitations on wood burning fireplaces or wood burning heaters: • At elevations below 3,000 feet in areas with natural gas service, no person shall install a wood burning fireplace, low mass fireplace, masonry heater, or wood burning heater. • At elevations at or above 3,000 feet or in areas without natural gas service, no more than two EPA certified wood burning heaters, that meet NSPS at time of installation, shall be installed per acre. ○ No person shall install more than one EPA certified wood burning heater that meets NSPS at time of installation, per dwelling unit. ○ No person shall install a wood burning fireplace, low mass fireplace, masonry heater, or non-certified wood burning heater.	No person or builder shall install a wood-burning device in a new building construction.
Requirements for Remodeling a Fireplace or Chimney	Remodel of wood burning fireplace or chimney where total cost exceeds $15,000, local building permit is required, and application for building permit is submitted on or after Jan. 1, 2020: • A person may only install a gas-fueled, electric, exempt, or EPA certified wood burning heater that meets requirements of NSPS at the time of installation.	No person shall remodel a fireplace or chimney unless a gas-fueled, electric, or EPA certified device is installed that meets requirements of 40 CFR 60 AAA. This requirement is triggered by a fireplace or chimney remodel where a total cost exceeds $15,000 and requires a local building permit.
Visible Emissions	• Under normal operating conditions, no person shall cause or allow any visible smoke from a registered wood burning heater. • Under normal operating conditions, no person shall cause or allow from a wood burning fireplace or nonregistered wood burning heater a visible emission of any air contaminant, other than uncombined water vapor, that exceeds No. 1 on the Ringelmann Chart or 20% opacity for a period or periods aggregating more than 3 minutes in any one (1) hour.	No person shall cause or allow a visible emission that exceeds Ringlemann 1 (20% opacity) for a period or periods aggregating more than 3 minutes in any hour. Visible emissions from startup shall not exceed 20 consecutive minutes in any consecutive four-hour period.

	SJVAPCD Rule 4901	BAAQMD Reg 6, Rule 3
Public Awareness Information	Retailers selling or offering for sale new wood burning heaters shall supply public awareness information with each sale in the form of pamphlets, brochures, or fact sheets on the following: proper installation, operation, and maintenance, fuel, health effects, weatherization methods for the home, proper sizing of wood burning heaters, and Burn Curtailments.	Any person offering for sale, selling or installing a new or used wood-burning device shall provide public awareness information to each purchaser of a wood-burning device in the form of pamphlets, brochures, or fact sheets. The information shall include the following statement: "Wood smoke contains harmful PM which is associated with numerous negative health impacts."
Solid Wood Fuel or Wood Sale	Advertising Requirements for Sale of Wood • No person shall sell, offer for sale, or supply any wood which is orally or in writing, advertised, described, or in any way represented to be "seasoned wood" unless the wood has a moisture content of ≤20% by weight. • The APCO may delegate another person or agency the authority to test wood for moisture content and determine compliance.	Any person offering for sale, selling or providing solid fuel or wood intended for use in a wood-burning device shall: • Attach a label to each package of solid fuel or wood sold that states "Use of this and other solid fuels may be restricted at times by law. Please check 1877-4-NO-BURN or www.8774noburn.org before burning." • If wood is seasoned (not to include manufactured logs), then the label must also state: "This wood meets air quality regulations for moisture content to be less then 20% by weight for cleaner burning." • If wood is NOT seasoned "This wood does NOT meet air quality regulations for moisture content and must be properly dried before burning."
Prohibited Fuels	No person shall cause or allow any of the following materials to be burned in a wood burning fireplace, wood burning heater, or outdoor wood burning device: garbage, treated wood, non-seasoned wood, plastic products, rubber products, waste petroleum products, paints and paint solvents, coal, or any other material not intended by a manufacturer for use as a fuel in a wood burning fireplace, wood burning heater, or outdoor wood burning device.	No person shall cause or allow any of the following materials to be burned in a wood-burning device: garbage, treated wood, non-seasoned wood, used or contaminated wood pallets, plastic products, rubber products, waste petroleum products, paints and paint solvents, coal, animal carcasses, glossy or colored paper, salt water driftwood, particle board, and any material not intended by the manufacturer for use as a fuel in a wood-burning device.

The District evaluated the requirements contained within BAAQMD Regulation 6, Rule 3 and found that District Rule 4901 is as stringent as or more stringent than BAAQMD Regulation 6, Rule 3.

Potential Emission Reduction Opportunities

Beyond the review of current regulations and rule requirements, the District performed an extensive review of the feasibility of technologies and measures implemented in other regions and potential new technologies and measures that may be feasible for implementation in the near future. However, the District did not identify additional emission reduction opportunities at this time.

Evaluation Findings

Rule 4901 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.20 RULE 4902 (RESIDENTIAL WATER HEATERS)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	0.20	0.20	0.20	0.20	0.20	0.21	0.21
NOx	1.32	1.31	1.22	1.16	1.17	1.19	1.19
	Winter Average - Tons per day						
PM2.5	0.26	0.27	0.27	0.27	0.27	0.27	0.27
NOx	1.76	1.74	1.62	1.55	1.56	1.58	1.58

District Rule 4902 Description

Adopted July 17, 1993, District Rule 4902 is a point-of-sale rule that limits NOx emissions from natural gas-fired residential water heaters with heat input rates less than or equal to 75,000 Btu/hr. The original rule enforced a NOx emissions limit of 40 nanograms of NOx per Joule of heat output (ng/J). Amendments in March 2009 strengthened the rule by enforcing a limit of 10 ng/J for new or replacement water heaters and a limit of 14 ng/J for instantaneous, or tankless, water heaters.

As a point-of-sale rule, Rule 4902 affects water heater manufacturers, plumbing wholesalers, retail home supply stores, plumbers and contractors, and homeowners. This source category encompasses several types of water heaters, including conventional storage water heaters, demand water heaters, heat pump water heaters, solar water heaters, and tankless coil and indirect water heaters. Water heater options also vary by fuel type, which includes electricity, fuel oil, geothermal energy, natural gas, propane, and solar energy.

Conventional storage water heaters are the most common. They have an insulated tank sized from 20 to 80 gallons and natural gas-fired units have a gas burner under the tank regulated by a thermostat. Demand water heaters, also known as instantaneous or tankless water heaters, heat water as it is required and do not use a storage tank. As soon as there is a demand for hot water, a gas burner heats cold water as it travels through a pipe in the unit. Natural gas-fired units generally provide hot water at a rate upwards of 5 gallons per minute.

A tankless coil water heater heats water flowing through a heat exchanger installed in a furnace or boiler. Similar to the tankless coil water heater, an indirect water heater uses a furnace or boiler. Fluid heated by the furnace or boiler circulates through a heat exchanger in a storage tank.

Manufacturers have focused on combustion modifications to meet the lower NOx limit, as required in other California air districts. Combustion modification systems reduce thermal NOx formation by changing the flame characteristics to reduce peak flame temperature. Different burner designs, such as low-NOx and ultra-low NOx burners, achieve combustion modification for residential water heaters. Some of the design principles used in low-NOx and ultra-low NOx burners include staged air burners, staged fuel burners, pre-mix burners, internal recirculation, and radiant burners.

Statewide Zero-Emission Standards for Building Appliances

CARB's *2022 State Strategy for the State Implementation Plan* (*2022 State SIP Strategy*) includes a commitment to develop and propose a zero-emissions standard for space and water heaters sold in the state to go into effect in 2030.[164] This goal is in alignment with California's climate strategy, which includes efforts towards building decarbonization, as laid out in CARB's *2022 Scoping Plan for Achieving Carbon Neutrality* (*2022 Scoping Plan*).[165] CARB has committed to conduct an extensive investigation into this measure, develop a proposed rule through meaningful public engagement, and bring the proposed rule before their Board by 2025. Upon fulfilling these commitments, the State expects to experience significant air quality and public health benefits.

In the development of the *2022 State SIP Strategy* and the *2022 Scoping Plan*, CARB examined the many factors involved in the transition to zero-emission appliances, and outlined the necessary process ahead to achieve building decarbonization. CARB's *2022 Scoping Plan* details a number of aspects that must be considered before implementing zero-emission appliance standards, including technical feasibility, costs and affordability, and consumer acceptance, adoption, awareness, and readiness. Additionally, CARB acknowledged the concerted effort needed across all levels of government, utilities, appliance manufacturers, developers, contractors, households, and businesses to achieve this goal successfully and equitably across the state.

CARB began the public process for the development of zero-emission appliance standards with a public workshop on May 10, 2023.[166] The District continues to support CARB in the development and implementation of this measure, as it will result in direct air quality and public health benefits for the Valley.

Zero-Emission Requirements in Other Areas

Other air districts around the State are considering strategies that are similar to that adopted by CARB under the *2022 Scoping Plan* and *2022 State SIP Strategy*. For example, on March 15, 2023, Bay Area AQMD adopted zero-emission requirements for new residential and commercial furnaces and water heaters, with compliance dates ranging from 2027-2031, depending on unit type and size. Similarly, South Coast AQMD has committed to adopt the zero-emission standard developed by CARB for new space and water heaters in new constructions and equipment replacement by 2030 in

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[164] CARB. *2022 State Strategy for the State Implementation Plan*, pp. 101-103. September 22, 2022. Retrieved from: https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf

[165] CARB. *2022 Scoping Plan for Achieving Carbon Neutrality*. December 15, 2022. Retrieved from: https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf

[166] CARB Zero-Emission Appliance Standards Webpage, Meetings & Workshops. Retrieved from: https://ww2.arb.ca.gov/our-work/programs/building-decarbonization/zero-emission-appliance-standards/meetings-workshops

their *2022 Air Quality Management Plan*, in addition to low-NOx and incentive-based strategies.[167]

As of September 2023, 76 cities and counties in California have adopted local ordinances requiring varying degrees of electrification for new buildings. Notably, the first ban on natural gas hookups, passed in the City of Berkeley, was recently overturned due to a recent federal court ruling on their 2019 ordinance. On April 17, 2023, the U.S. Ninth Circuit Court of Appeals issued a ruling that cities and states cannot ban natural gas hookups in new buildings, because such action is preempted by the U.S. Energy Policy Conservation Act. This court ruling may impact other cities and counties that have adopted similar regulations that attempt to control the energy use of equipment. Berkeley is currently seeking a re-hearing of the Ninth Circuit's decision.

How does District Rule 4902 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Techniques Guidelines, Alternative Control Techniques, or New Source Performance Standards applicable to this source category.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4902 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4902 to comparable requirements in rules from the following California nonattainment areas:

- Bay Area AQMD Regulation 9, Rule 6 (Amended March 15, 2023)[168]
- Sacramento Metropolitan AQMD Rule 414 (Amended October 25, 2018)[169]
- San Diego County APCD Rule 69.5.1 (Adopted June 24, 2015)[170]

[167] SCAQMD. *2022 Air Quality Management Plan*. (December 2, 2022). Retrieved from: http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2022-air-quality-management-plan/final-2022-aqmp/final-2022-aqmp.pdf?sfvrsn=10

[168] BAAQMD. *Regulation 9, Rule 6 (Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters).* (Amended March 15, 2023). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-4-nitrogen-oxides-from-fan-type-residential-central-furnaces/2021-amendments/documents/20230315_rg0906-pdf.pdf?la=en

[169] SMAQMD. *Rule 414 (Water Heaters, Boilers, and Process Heaters Rated Less than 1,000,000 BTU Per Hour).* (Amended October 25, 2018). Retrieved from: http://www.airquality.org/ProgramCoordination/Documents/rule414.pdf

[170] SDAPCD. *Rule 69.5.1 (Natural Gas-Fired Water Heaters).* (Adopted June 24, 2015). Retrieved from: https://www.sdapcd.org/content/dam/sdapcd/documents/rules/current-rules/Rule-69.5.1.pdf

- South Coast AQMD Rule 1121 (Amended September 3, 2004)[171]
- Ventura County APCD Rule 74.11 (Amended January 12, 2010)[172]

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4902 continues to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rules is demonstrated below.

Bay Area AQMD

- BAAQMD Regulation 9, Rule 6 (Nitrogen Oxide Emissions from Natural Gas-Fired Boilers and Water Heaters)

	SJVAPCD Rule 4902	BAAQMD Reg 9, Rule 6
Applicability	Manufacturers, distributors, retailers, and installers of PUC quality natural gas-fired residential water heaters with heat input rates ≤75,000 Btu/hr.	Any person who sells, installs, or offers for sale a natural gas-fired water heater for use within the District and any manufacturer who intends to sell or distribute for sale or installation a natural gas-fired water heater for use within the District.
Exemptions	• PUC quality natural gas fired water heaters with rated heat input of >75,000 Btu/hr • Water heaters using fuels other than PUC quality natural gas • Water heaters used exclusively in recreational vehicles	The requirements below shall not apply to the following: • Natural gas-fired boilers and water heaters with a rated heat input capacity >2,000,000 Btu/hr • Natural gas-fired water heaters used in recreational vehicles • Water heaters using a fuel other than natural gas • Natural gas-fired pool/spa heaters with <400,000 Btu/hr rated heat input capacity used exclusively to heat swimming pools, hot tubs or spas
Requirements	No person shall manufacture for sale, distribute, sell, offer for sale, or install within the District any PUC quality natural gas-fired: • Water heater (excluding mobile home water heaters, instantaneous water heaters, and pool heaters) unless certified to a NOx emission level of ≤10 ng/J • Instantaneous water heater unless certified to a NOx emission level of ≤14 ng/J	No person shall sell, install, or offer for sale within the District any natural gas-fired boiler or water heater that emits more than the following NOx limits: • ≤75,000 Btu/hr: ○ 10 ng/J; ○ 0 ng/J for new units after Jan. 1, 2027 • Mobile home water heater: ○ 40 ng/J • Pool/spa heater 400,001 to 2,000,000 Btu/hr: ○ 14 ng/J

[171] SCAQMD. *Rule 1121 (Control of Nitrogen Oxides from Residential Type, Natural Gas-Fired Water Heaters).* (Amended September 3, 2004). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1121.pdf?sfvrsn=4
[172] VCAPCD. *Rule 74.11 (Natural Gas-Fired Water Heaters).* (Revised January 12, 2010). Retrieved from: http://www.vcapcd.org/Rulebook/Reg4/RULE%2074.11.pdf

	SJVAPCD Rule 4902	BAAQMD Reg 9, Rule 6
	• Mobile home water heater unless certified to a NOx emission level of ≤40 ng/J • Pool heater unless certified to a NOx emission level of ≤40 ng/J	

Currently, applicable water heaters in the Bay Area are subject to the same 10 ng/J NOx limit as units subject to District Rule 4902. Recent amendments to BAAQMD Regulation 9, Rule 6 established a zero-NOx standard for new residential water heaters, set to begin in 2027. Notably, this limit takes effect well beyond the date by which the District is required to implement BACM. Additionally, BAAQMD acknowledges that there are uncertainties in their proposed implementation timeline for zero-NOx requirements, and has stated that their Governing Board may choose to consider amending the compliance dates should it be later determined that sufficient zero-NOx technologies are not available.[173] For these reasons, BAAQMD's future limit cannot be considered as establishing BACM at this time.

Sacramento Metropolitan AQMD

- SMAQMD Rule 414 (Water Heaters, Boilers and Process Heaters Rated Less than 1,000,000 BTU Per Hour)

	SJVAPCD Rule 4902	SMAQMD Rule 414
Applicability	Manufacturers, distributors, retailers, and installers of PUC quality natural gas-fired residential water heaters with heat input rates ≤75,000 Btu/hr.	Any person who manufactures, distributes, offers for sale, sells, or installs any type of water heater (such as tank or tankless/instantaneous), boiler or process heater, with a rated heat input capacity <1,000,000 Btu/hr, fired with gaseous or nongaseous fuels, for use in this District.
Exemptions	• PUC quality natural gas fired water heaters with rated heat input of >75,000 Btu/hr • Water heaters using fuels other than PUC quality natural gas • Water heaters used exclusively in recreational vehicles	• Water heaters used in recreational vehicles • Pool/spa heaters with a heat input rating <75,000 Btu/hr • Water heaters, boilers and process heaters fired with LPG • Hot water pressure washers fired with gaseous or liquid fuels
Requirements	No person shall manufacture for sale, distribute, sell, offer for sale, or install within the District any PUC quality natural gas-fired: • Water heater (excluding mobile home water heaters, instantaneous water heaters, and pool heaters) unless	A person shall only distribute, offer for sale, sell, or install a water heater, boiler, or process heater with certified NOx and CO emissions less than or equal to the following limits: • <75,000 Btu/hr: ○ Mobile home: 40 ng/J;

[173] BAAQMD. *Final Staff Report for the Proposed Amendments to Building Appliance Rules – Regulation 9, Rule 4: Nitrogen Oxides from Fan Type Residential Central Furnaces and Rule 6: Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters.* (March 2023). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-4-nitrogen-oxides-from-fan-type-residential-central-furnaces/2021-amendments/documents/20230307_fsr_rules0904and0906-pdf.pdf?la=en

	SJVAPCD Rule 4902	SMAQMD Rule 414
	certified to a NOx emission level of ≤10 ng/J • Instantaneous water heater unless certified to a NOx emission level of ≤14 ng/J • Mobile home water heater unless certified to a NOx emission level of ≤40 ng/J • Pool heater unless certified to a NOx emission level of ≤40 ng/J	o All others: 10 ng/J • 75,000 to <400,000 Btu/hr: o Pool/Spa: 40 ng/J; o All others: 14 ng/J • 400,000 to <1 million Btu/hr: o All types: 14 ng/J NOx and 400 ppmv CO @ 3% O2

The District evaluated the requirements contained within SMAQMD Rule 414 and found no requirements that were more stringent than those already in District Rule 4902. Therefore, District Rule 4902 is as stringent as or more stringent than SMAQMD Rule 414.

San Diego County APCD

- SDAPCD Rule 69.5.1 (Natural Gas-Fired Water Heaters)

	SJVAPCD Rule 4902	SDAPCD Rule 69.5.1
Applicability	Manufacturers, distributors, retailers, and installers of PUC quality natural gas-fired residential water heaters with heat input rates ≤75,000 Btu/hr.	Manufacturers, distributors, retailers, and installers of natural gas-fired water heaters, with heat input rates <75,000 Btu/hr.
Exemptions	• PUC quality natural gas fired water heaters with rated heat input of >75,000 Btu/hr • Water heaters using fuels other than PUC quality natural gas • Water heaters used exclusively in recreational vehicles	• Water heaters with a rated heat input capacity of ≥75,000 Btu/hr • Water heaters used in recreational vehicles • Water heaters used exclusively to heat swimming pools and hot tubs • Water heaters using fuels other than natural gas • Instantaneous water heaters • Existing or relocated water heaters
Requirements	No person shall manufacture for sale, distribute, sell, offer for sale, or install within the District any PUC quality natural gas-fired: • Water heater (excluding mobile home water heaters, instantaneous water heaters, and pool heaters) unless certified to a NOx emission level of ≤10 ng/J • Instantaneous water heater unless certified to a NOx emission level of ≤14 ng/J • Mobile home water heater unless certified to a NOx emission level of ≤40 ng/J • Pool heater unless certified to a NOx emission level of ≤40 ng/J	• No person shall manufacture for sale, distribute, sell, offer for sale, or install any gas-fired water heaters unless it is certified to a NOx emission level of ≤10 ng/J; or 15 ppmv at 3% O2, dry • No person shall manufacture for sale, distribute, sell, offer for sale, or install any gas-fired mobile home water heater unless it is certified to a NOx emission level of ≤40 ng/J; or 55 ppmv at 3% O2, dry

The District evaluated the requirements contained within SDAPCD Rule 69.5.1 and found no requirements that were more stringent than those already in District Rule 4902. Therefore, District Rule 4902 is as stringent as or more stringent than SDAPCD Rule 69.5.1.

Potential Emission Reduction Opportunities

In an effort to identify potential emission reduction opportunities, the District's *2022 Ozone Plan* includes a further study commitment to evaluate current and upcoming work from CARB and other agencies related to reducing emissions from residential and commercial combustion sources, and evaluate the feasibility of implementing zero-emission or low-NOx requirements for these sources in the Valley. Through this effort, the District will also evaluate opportunities to advocate for funding under the Inflation Reduction Act, Bipartisan Infrastructure Law, and other funding sources, which are prioritizing funding opportunities for electrification of appliances to reduce greenhouse gas emissions. The District will continue to closely track regulations being developed by CARB, SCAQMD, BAAQMD, and others. Additionally, although the District currently implements BACM for this source category, the District remains committed to pursuing electrification opportunities, taking into consideration equitable and feasible strategies.

Evaluation Findings

Rule 4902 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.21 RULE 4905 (NATURAL GAS-FIRED, FAN-TYPE CENTRAL FURNACES)

Emissions Inventory

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	0.28	0.29	0.29	0.29	0.29	0.29	0.29
NOx	3.45	3.39	3.11	2.84	2.58	2.41	2.32
	Winter Average - Tons per day						
PM2.5	0.35	0.37	0.37	0.37	0.37	0.37	0.37
NOx	4.37	4.30	3.94	3.60	3.26	3.05	2.94

District Rule 4905 Description

District Rule 4905 is a point of sale rule that applies to any person who sells, offers for sale, installs or solicits the installation of natural-gas-fired, fan-type central furnaces for use in the Valley with a rated heat input capacity of less than 175,000 Btu/hour, and for combination heating and cooling units with a rated cooling capacity of less than 65,000 Btu/hour. Adopted on October 20, 2005, Rule 4905 established NOx limits for residential central furnaces supplied, sold, or installed in the Valley. January 2015 amendments lowered the NOx emission limit for residential units from 40 ng/J (0.093 lb/MMBtu) to 14 ng/J, and expanded rule applicability to include commercial units with a NOx emission limit of 14 ng/J and units installed in manufactured homes with a NOx emission limit of 40 ng/J to be lowered to 14 ng/J in 2018. The amendments allowed for the sale of non-compliant units during an initial 36-month implementation period in exchange for the payment of an emissions fee for each non-compliant unit sold, distributed, or installed in the Valley. EPA approved these amendments into the SIP effective April 28, 2016.[174]

The District has subsequently amended District Rule 4905 several times to extend the implementation period for certain unit types as a response to the limited number of certified compliant units available by the compliance deadline dates. This allowed additional time necessary to continue technology development and the certification process, while providing strong incentive for accelerated deployment of compliant units.

The most common type of heating system for residential and commercial buildings are furnaces fueled by natural gas that use forced air distribution. A thermostat controls the central furnace, which sends a signal to turn the unit on or off when the building temperature does not match a chosen set point. A valve then opens to send natural gas to the burners, which combusts the gas directly into the heat exchangers. A blower pulls air from inside the building through a filter, across the heat exchanger, and through

[174] EPA. *Approval of California Air Plan Revisions, San Joaquin Valley Unified Air Pollution Control District and South Coast Air Quality Management District. Final Rule*. 81 FR 17390. (March 29, 2016). (Codified at 40 CFR Part 52). Retrieved from: https://www.gpo.gov/fdsys/pkg/FR-2016-03-29/pdf/2016-06962.pdf

a series of ducts and vents to different areas of the building. Exhaust from the combustion exits the building through a separate duct.

Condensing units use an additional heat exchanger to extract the latent heat in the flue (exhaust) gas by cooling the combustion gasses to near ambient temperature and thereby increase the heating efficiency by up to 10%. The water vapor in the flue gas is condensed, collected, and drained.

Units installed in manufactured homes use the same types of materials and operating principles as commercial and residential units; however, significant differences exist. Furnaces installed in manufactured homes use sealed combustion, pre-heat the air typically to 50-60°F, use a concentric vent, and exhaust gases are vented through the inside core of the vent pipe. Furnaces installed in manufactured homes also have to comply with strict space restrictions.[175]

Statewide Zero-Emission Standards for Building Appliances

CARB's *2022 State SIP Strategy* includes a commitment to develop and propose a zero-emissions standard for space and water heaters sold in the state to go into effect in 2030.[176] This goal is in alignment with California's climate strategy, which includes efforts towards building decarbonization, as laid out in CARB's *2022 Scoping Plan*.[177] CARB has committed to conduct an extensive investigation into this measure, develop a proposed rule through meaningful public engagement, and bring the proposed rule before their Board by 2025. Upon fulfilling these commitments, the State expects to experience significant air quality and public health benefits.

In the development of the *2022 State SIP Strategy* and the *2022 Scoping Plan*, CARB examined the many factors involved in the transition to zero-emission appliances, and outlined the necessary process ahead to achieve building decarbonization. CARB's *2022 Scoping Plan* details a number of aspects that must be considered before implementing zero-emission appliance standards, including technical feasibility, costs and affordability, and consumer acceptance, adoption, awareness, and readiness. Additionally, CARB acknowledged the concerted effort needed across all levels of government, utilities, appliance manufacturers, developers, contractors, households, and businesses to achieve this goal successfully and equitably across the state.

CARB began the public process for the development of zero-emission appliance standards with a public workshop on May 10, 2023.[178] The District continues to support

[175] U.S. Department of Energy. *Energy Conservation Program for Consumer Products: Energy Conservation Standards for Residential Furnace Fans.* (July 7, 2014). Retrieved from: https://www.federalregister.gov/articles/2014/07/03/2014-15387/energy-conservation-program-for-consumer-products-energy-conservation-standards-for-residential

[176] CARB. *2022 State Strategy for the State Implementation Plan*, pp. 101-103. (September 22, 2022). Retrieved from: https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf

[177] CARB. *2022 Scoping Plan for Achieving Carbon Neutrality*. (December 15, 2022). Retrieved from: https://ww2.arb.ca.gov/sites/default/files/2023-04/2022-sp.pdf

[178] CARB Zero-Emission Appliance Standards Webpage, Meetings & Workshops. Retrieved from: https://ww2.arb.ca.gov/our-work/programs/building-decarbonization/zero-emission-appliance-standards/meetings-workshops

CARB in the development and implementation of this measure, as it will result in direct air quality and public health benefits for the Valley.

Zero-Emission Requirements in Other Areas
Other air districts around the State are considering strategies that are similar to that adopted by CARB under the *2022 Scoping Plan* and *2022 State SIP Strategy*. For example, on March 15, 2023, Bay Area AQMD adopted zero-emission requirements for new residential and commercial furnaces and water heaters, with compliance dates ranging from 2027-2031, depending on unit type and size. Similarly, South Coast AQMD has committed to adopt the zero-emission standard developed by CARB for new space and water heaters in new constructions and equipment replacement by 2030 in their *2022 Air Quality Management Plan*, in addition to low-NOx and incentive-based strategies.[179]

As of September 2023, 76 cities and counties in California have adopted local ordinances requiring varying degrees of electrification for new buildings. Notably, the first ban on natural gas hookups, passed in the City of Berkeley, was recently overturned due to a recent federal court ruling on their 2019 ordinance. On April 17, 2023, the U.S. Ninth Circuit Court of Appeals issued a ruling that cities and states cannot ban natural gas hookups in new buildings, because such action is preempted by the U.S. Energy Policy Conservation Act. This court ruling may impact other cities and counties that have adopted similar regulations that attempt to control the energy use of equipment. Berkeley is currently seeking a re-hearing of the Ninth Circuit's decision.

How does District Rule 4905 compare with federal and state rules and regulations?

Federal Regulations

There are no Control Techniques Guidelines, Alternative Control Techniques, or New Source Performance Standards applicable to this source category.

State Regulations

There are no state regulations applicable to this source category.

How does District Rule 4905 compare to rules in other air districts?

The District compared emission limits, optional control requirements, and work practice standards in District Rule 4905 to comparable requirements in rules from the following California nonattainment areas:

[179] SCAQMD. *2022 Air Quality Management Plan*. (December 2, 2022). Retrieved from: http://www.aqmd.gov/docs/default-source/clean-air-plans/air-quality-management-plans/2022-air-quality-management-plan/final-2022-aqmp/final-2022-aqmp.pdf?sfvrsn=10

- Bay Area AQMD Regulation 9, Rule 4 (Amended March 15, 2023)[180]
- San Diego County APCD Rule 69.6 (Adopted June 17, 1998)[181]
- South Coast AQMD Rule 1111 (Amended October 1, 2021)[182]
- Ventura County APCD Rule 74.22 (Adopted November 9, 1993)[183]

Sacramento Metropolitan AQMD does not have an analogous rule for this source category.

The District reviewed rule requirements implemented prior to EPA's approval of BACM/MSM for the *2018 PM2.5 Plan*, and found that District Rule 4905 continues to implement requirements as stringent as or more stringent than these other areas. The District's evaluation of the more recently amended rules is demonstrated below.

Bay Area AQMD

- BAAQMD Regulation 9, Rule 4 (Nitrogen Oxides from Fan Type Residential Central Furnaces)

	SJVAPCD Rule 4905	BAAQMD Reg 9, Rule 4
Applicability	Residential and commercial furnaces with rated heat input capacity of <175,000 btu/hr or <65,000 btu/hr for combination heating and cooling units.	Any person who sells, installs, or offers for sale a natural gas-fired furnace and any manufacturer who intends to sell or distribute for sale or installation a natural gas-fired furnace, with rated heat input capacity of <175,000 btu/hr.
Exemptions	Natural gas furnace not exceeding NOx emissions of 40 ng/J and installed with propane conversion kit for propane firing only.	Furnaces used for mobile homes.
Requirements	Furnaces must not exceed a NOx limit of 14 ng/J.	A person shall not sell, install, or offer for sale any natural gas-fired fan type central furnace that emits more than: • 40 ng/J; • 14 ng/J for new units after Jan. 1, 2024; • 0.0 ng/J for new units after Jan. 1, 2029

Currently, applicable furnaces in the Bay Area are subject to a much higher NOx limit of 40 ng/J, with a 14 ng/J NOx limit to be implemented in 2024. Recent amendments to

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[180] BAAQMD*. Regulation 9, Rule 4 (Nitrogen Oxides from Fan Type Residential Central Furnaces).* (Amended December 7, 1983). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-4-nitrogen-oxides-from-fan-type-residential-central-furnaces/documents/rg0904.pdf?la=en&rev=e67bf6e164d94de39b44caa30ce17fd7
[181] SDAPCD. *Rule 69.6 (Natural Gas-Fired Fan Type Central Furnaces).* (Adopted June 17, 1998). Retrieved from: https://www.sdapcd.org/content/dam/sdapcd/documents/rules/current-rules/Rule-69.6.pdf
[182] SCAQMD. *Rule 1111 (Reduction of NOx Emissions from Natural-Gas-Fired, Fan-Type Central Furnaces).* (Amended October 1, 2021). Retrieved from: http://www.aqmd.gov/docs/default-source/rule-book/reg-xi/rule-1111.pdf?sfvrsn=4
[183] VCAPCD. *Rule 74.22 (Natural Gas-Fired, Fan-Type Central Furnaces).* (Amended November 9, 1993). Retrieved from: http://www.vcapcd.org/Rulebook/Reg4/RULE%2074.22.pdf

BAAQMD Regulation 9, Rule 4 established a future zero-NOx standard for new furnaces that is set to begin in 2029. Notably, this limit takes effect well beyond the date by which the District is required to implement BACM. Additionally, BAAQMD acknowledges that there are uncertainties in their proposed implementation timeline for zero-NOx requirements, and has stated that their governing board may choose to consider amending the compliance dates should it be later determined that sufficient zero-NOx technologies are not available.[184] For these reasons, BAAQMD's future limit cannot be considered as establishing BACM at this time.

South Coast AQMD

- SCAQMD Rule 1111 (Reduction of NOx Emissions from Natural-Gas-Fired, Fan-Type Central Furnaces)

	SJVAPCD Rule 4905	SCAQMD Rule 1111
Applicability	Residential and commercial furnaces with rated heat input capacity of <175,000 btu/hr or <65,000 btu/hr for combination heating and cooling units.	Residential and commercial furnaces with rated heat input capacity of <175,000 btu/hr or <65,000 btu/hr for combination heating and cooling units.
Exemptions	Natural gas furnace not exceeding NOx emissions of 40 ng/J and installed with propane conversion kit for propane firing only.	• Furnaces installed in mobile homes before Oct. 1, 2012 • Natural gas furnace installed with propane conversion kit for propane firing only • Downflow and large-sized (≥100,000 btu/hr) condensing and noncondensing furnaces, replacing existing furnaces in the high-altitude areas
Requirements	Furnaces must not exceed a NOx limit of 14 ng/J.	Furnaces must not exceed a NOx limit of 14 ng/J.

The District evaluated the requirements contained within SCAQMD Rule 1111 and found no requirements that were more stringent than those already in District Rule 4905. Therefore, District Rule 4905 is as stringent as or more stringent than SCAQMD Rule 1111.

Potential Emission Reduction Opportunities

In an effort to identify potential emission reduction opportunities, the District's *2022 Ozone Plan* includes a further study commitment to evaluate current and upcoming work from CARB and other agencies related to reducing emissions from residential and commercial combustion sources, and evaluate the feasibility of implementing zero-emission or low-NOx requirements for these sources in the Valley. Through this effort, the District will also evaluate opportunities to advocate for funding under the Inflation Reduction Act, Bipartisan Infrastructure Law, and other funding sources, which are

[184] BAAQMD. *Final Staff Report for the Proposed Amendments to Building Appliance Rules – Regulation 9, Rule 4: Nitrogen Oxides from Fan Type Residential Central Furnaces and Rule 6: Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters.* (March 2023). Retrieved from: https://www.baaqmd.gov/~/media/dotgov/files/rules/reg-9-rule-4-nitrogen-oxides-from-fan-type-residential-central-furnaces/2021-amendments/documents/20230307_fsr_rules0904and0906-pdf.pdf?la=en

prioritizing funding opportunities for electrification of appliances to reduce greenhouse gas emissions. The District will continue to closely track regulations being developed by CARB, SCAQMD, BAAQMD, and others. Additionally, although the District currently implements BACM for this source category, the District remains committed to pursuing electrification opportunities, taking into consideration equitable and feasible strategies.

Evaluation Findings

Rule 4905 currently provides for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meets or exceeds BACM requirements.

2.22 REGULATION VIII (FUGITIVE PM10 PROHIBITIONS)

Emissions Inventory

Rule 8021: Construction, Demolition, Excavation, Extraction, and Other Earthmoving Activities

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	1.32	1.44	1.54	1.74	1.65	2.84	1.82
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day						
PM2.5	1.21	1.32	1.42	1.59	1.51	2.60	1.66
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Rule 8031: Bulk Materials

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day						
PM2.5	0.03	0.03	0.03	0.03	0.03	0.03	0.03
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Rule 8041: Carryout and Trackout

The emissions from this source category are included in the inventory for Rule 8061 (Paved and Unpaved Roads).

Rule 8051: Open Areas

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	0.34	0.34	0.34	0.34	0.34	0.34	0.34
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day						
PM2.5	0.21	0.21	0.21	0.21	0.21	0.21	0.21
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Rule 8061: Paved and Unpaved Roads

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	6.68	6.82	7.00	7.20	7.40	7.50	7.54
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day						
PM2.5	5.80	5.93	6.10	6.29	6.48	6.58	6.62
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Rule 8071: Unpaved Vehicle/Equipment Traffic Areas

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	0.59	0.59	0.58	0.58	0.58	0.57	0.57
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day						
PM2.5	0.60	0.60	0.59	0.59	0.59	0.58	0.58
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Rule 8081: Agricultural Sources

	2017	2019	2022	2025	2028	2030	2031
	Annual Average - Tons per day						
PM2.5	1.18	1.17	1.16	1.15	1.14	1.14	1.14
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day						
PM2.5	0.73	0.72	0.72	0.71	0.71	0.70	0.70
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Rule Descriptions

The District's Regulation VIII series (Fugitive PM10 Prohibitions) was adopted in November 2001, and subsequently amended in 2004. This rule series contains a comprehensive suite of rules designed to reduce fugitive PM10 emissions from a range of sources, as further described below:

Rule 8011: General Requirements
The provisions of Rule 8011 are applicable to specified outdoor fugitive dust sources. The definitions, exemptions, general requirements, administrative requirements, recordkeeping requirements, and test methods set forth in this rule are applicable to all rules under District Regulation VIII. The rules were developed pursuant to EPA guidelines for serious PM10 nonattainment areas. In 2004, the District adopted

amendments to Regulation VIII to upgrade existing RACM level rules to meet the more stringent BACM level required in serious PM10 nonattainment areas.

Rule 8021: Construction, Demolition, Excavation, Extraction, and Other Earthmoving Activities
Rule 8021 applies to construction or demolition related disturbances of soil, including land clearing, grubbing, scraping, excavation, extraction, land leveling, grading, cut and fill operations, travel on the site, travel access roads to and from the site, and demolition activities. The rule also applies to construction of new landfill disposal sites or modifications to existing landfill disposal sites prior to commencement of landfilling activities. In 2004, Rule 8021 was amended to add dust suppression requirements, and to require submittal of Dust Control Plans on residential construction sites 10.0 acres or more in size and on non-residential construction sites 5.0 acres or more in size.

Rule 8031: Bulk Materials
Rule 8031 applies to the outside storage and handling of any unpackaged material, which emits or has the potential to emit dust when stored or handled. Rule 8031 requires bulk handling and storage facilities to restrict dust from material transfer, and reduce emissions from transport material and storage piles that emit dust. Facilities subject to Rule 8031 are required to use control measures to ensure that visible dust emissions (VDE) are limited to 20% opacity or less. These control measures can include application of water or other dust stabilizers, covering of bulk materials, construction of wind barriers, covering of haul trucks, and other measures. In 2004, Rule 8031 was amended to require the construction and maintenance of wind barriers when handling bulk materials.

Rule 8041: Carryout and Trackout
Rule 8041 applies to the prevention and cleanup of mud and dirt whenever it is deposited (carryout and trackout) onto public paved roads from activities subject to the requirements of Rules 8021, 8031, 8061, and 8071. The rule contains requirements for: removing carryout and trackout at the end of each workday; carryout and trackout thresholds for any site with 150 or more daily vehicle trips; addressing carryout and trackout in Dust Control Plans; removing carryout and trackout in urban areas; paved interior roads; and prevention of carryout and trackout. Rule 8041 was amended in 2004 to require a threshold for vehicles with three or more axles to takes actions for carryout and trackout. Amendments included a threshold for projects located in rural areas, a provision requiring actions within half an hour if specified measures are insufficient to prevent carryout and trackout, and specifications for dust collectors, gravel pads, and paved surfaces.

Rule 8051: Open Areas
Rule 8051 applies to any open area 0.5 acres or more within urban areas, or 3.0 acres or more within rural areas that contains at least 1,000 square feet of disturbed surface area. The rule has requirements for limiting VDE to 20% opacity, to comply with the conditions of a stabilized surface, and to install barriers to prevent unauthorized vehicles from accessing the stabilized areas. Rule 8051 was amended in 2004 to add applicability thresholds for rural and urban areas.

Rule 8061: Paved and Unpaved Roads
Rule 8061 establishes standards for the construction of new and modified paved roads in accordance with published guidelines by the American Association of State Highway and Transportation Officials for road construction, and applies to any paved, unpaved, or modified public or private road, street highway, freeway, alley way, access drive, access easement, or driveway. The rule also allows alternative means of achieving the same level of dust reduction. Rule 8061 establishes thresholds that, when exceeded, require roads to be treated to reduce VDE. Rule 8061 was amended in 2004 to replace the existing 75 maximum vehicle daily trip (VDT) threshold with a 26 annual average daily trips (AADT) threshold on unpaved roads, and to require that all new roads within urban areas be paved.

Rule 8071: Unpaved Vehicle/Equipment Traffic Areas
Rule 8071 is applicable to unpaved vehicle and equipment areas, including parking, fueling, service, shipping, receiving, and transfer areas. The rule contains requirements for when vehicle traffic reaches or exceeds specified thresholds, limitations on VDE, compliance requirements with the conditions of a stabilized surface, and lists control techniques, which could be implemented to limit VDE and to comply with the conditions of a stabilized surface. Rule 8071 was amended in 2004 to: remove the 1.0 acre or larger threshold; change the vehicle threshold from 75 VDT to 50 AADT; add a single day peak threshold of 150 VDT or require control for sources that exceed the 150 VDT threshold limit on at least 30 days per year; and add a requirement specific to whenever 25 or more three-axle vehicle trips occur on an unpaved vehicle/equipment traffic area.

Rule 8081: Agricultural Sources
Rule 8081 applies to “off-field” agricultural sources including, but not limited to, unpaved roads, unpaved vehicle and equipment traffic areas, and bulk materials. The rule contains requirements to limit VDE and/or to comply with the conditions of a stabilized surface, and lists control techniques that could be implemented to limit VDE and to comply with the conditions of a stabilized surface. Rule 8081 was amended in 2004 to: add an exemption to the rule for vehicle and equipment traffic areas if they are less than one acre in size and more than one mile from an urban area; expand rule applicability by updating the vehicle threshold from 75 VDT to 50 annual average vehicle trips; and add a requirement specific to whenever 26 or more three-axle vehicle trips will occur on an unpaved vehicle and equipment traffic area.

How does District Regulation VIII compare with federal and state rules and regulations?

Federal Regulations
There are no Control Techniques Guidelines, Alternative Control Techniques, or New Source Performance Standards applicable to this source category. The following federal regulations apply to sources covered under Regulation VIII:

- *Rule 57 FR 13498 – General Preamble for Title I of CAA*

The District evaluated the requirements contained within the General Preamble and found no requirements that were more stringent than those already in Regulation VIII.

- *Fugitive Dust Background Document and Technical Information Document for BACM* (EPA-450/2-92-004 1992/09)

The District evaluated the requirements contained within the Fugitive Dust Background Document and Technical Information Document for BACM and found no requirements that were more stringent than those already in Regulation VIII.

State Regulations

There are no state regulations applicable to this source category.

How does District Regulation VIII compare to rules in other air districts?

Bay Area AQMD does not have an analogous rule for this source category.

SCAQMD

- Rule 1156 (Further Reductions of Particulate Emissions from Cement Manufacturing Facilities) (*Last amended November 6, 2015*)

The District evaluated the requirements contained within SCAQMD Rule 1156 and found that overall Regulation VIII is as stringent as or more stringent than Rule 1156.

- Rule 1157 (PM10 Emission Reductions form Aggregate and Related Operations) (*Last amended September 8, 2006*)

The District evaluated the requirements contained within SCAQMD Rule 1157 and found that overall Regulation VIII is as stringent as or more stringent than Rule 1157.

SMAQMD

- Rule 403 (Fugitive Dust) (*Last amended August 3, 1977*)

The District evaluated the requirements contained within SMAQMD Rule 403 and found that overall Regulation VIII is as stringent as or more stringent than Rule 403.

VCAPCD

- Rule 55 (Fugitive Dust) (*Adopted June 10, 2008*)

The District evaluated the requirements contained within VCAPCD Rule 55 and found that overall Regulation VIII is as stringent as or more stringent than Rule 55.

Clark County Department of Environment and Sustainability (CCDES)

- Section 41 (Fugitive Dust) (*Last amended January 21, 2020*)

The District evaluated the requirements contained within CCDES Section 41 and found that overall Regulation VIII is as stringent as or more stringent than Section 41.

- Section 91 (Fugitive Dust from Unpaved Roads, Unpaved Alleys, and Unpaved Easement Roads) (*Last amended April 15, 2014*)

The District evaluated the requirements contained within CCDES Section 91 and found that overall Regulation VIII is as stringent as or more stringent than Section 91.

- Section 92 (Fugitive Dust from Unpaved Parking Lots and Storage Areas) (*Last amended August 3, 2021*)

The District evaluated the requirements contained within CCDES Section 92 and found that overall Regulation VIII is as stringent as or more stringent than Section 92.

- Section 93 (Fugitive Dust from Paved Roads and Street Sweeping Equipment) (*Last amended January 21, 2020*)

The District evaluated the requirements contained within CCDES Section 93 and found that overall Regulation VIII is as stringent as or more stringent than Section 93.

- Section 94 (Permitting and Dust Control for Construction and Temporary Commercial Activities) (*Last amended August 3, 2021*)

The District evaluated the requirements contained within CCDES Section 94 and found that overall Regulation VIII is as stringent as or more stringent than Section 94.

Great Basin APCD Rule 433 (Control of Particulate Emissions at Owens Lake)

- Section 41 (Fugitive Dust) (*Adopted April 13, 2016*)

The District evaluated the requirements contained within Great Basin APCD Rule 433 and found that overall Regulation VIII is as stringent as or more stringent than Rule 433.

Potential Emission Reduction Opportunities

While District Regulation VIII was critical in the District's attainment of the PM10 standards, a variety of studies have been conducted which indicate that the PM2.5 fraction of the PM emissions from this source category may not be as significant as the PM coarse fraction. A better quantification of the PM2.5 fraction is required to develop a more accurate emissions inventory for the various activities under Rule 8021 and to indicate the level of significance of those PM2.5 emissions. Modeling results show that the geologic fraction of PM2.5 found in the Valley makes a relatively small contribution to overall PM2.5 mass.

As demonstrated above, Regulation VIII currently employs the best dust mitigation techniques. The District did not identify any additional emission reduction opportunities at this time.

Evaluation Findings

The District's Regulation VIII rules currently provide for the maximum degree of emissions reductions achievable for this source category by 2025, and therefore meet or exceed BACM requirements.

2.23 EMISSION INVENTORY CODE (EIC) TABLE

Control Measure	Emission Inventory Codes
Rule 4103 (Open Burning)	670-660-0262-0000; 670-660-0262-9842; 670-660-0262-9856; 670-660-0262-9862; 670-660-0262-9874; 670-660-0262-9884; 670-660-0262-9888; 670-660-0262-9892; 670-662-0262-0000; 670-662-0262-9866; 670-662-0262-9878; 670-662-0262-9882; 670-668-0200-9858; 670-668-0200-9872; 670-668-0200-9886; 670-995-0240-9848; 670-995-0240-9852; 670-995-0240-9854; 670-995-0240-9868
Rule 4104 (Reduction of Animal Matter)	420-995-6004-0000
Rule 4106 (Prescribed Burning and Hazard Reduction Burning)	670-664-0200-0000; 670-666-0200-0000; 670-668-0200-0000; 670-668-0200-9894; 670-670-0200-0000;
Rule 4203 (Particulate Matter Emissions from Incineration of Combustible Refuse)	There is no specific emissions inventory associated with Rule 4203.
Rule 4204 (Cotton Gins)	420-418-6028-0000; 420-420-6028-0000
Rule 4301 (Fuel Burning Equipment)	There is no specific emissions inventory associated with Rule 4301.
Rule 4307 (Boilers, Steam Generators, and Process Heaters - 2.0 to 5.0 MMBtu/hr)	010-005-0110-0000; 010-005-0124-0000; 010-005-0130-0000; 010-005-0300-0000; 010-005-1220-0000; 010-005-1530-0000; 010-010-0110-0000; 020-005-0110-0000; 030-005-0110-0000; 030-005-0122-0000; 030-005-0124-0000; 030-005-0130-0000; 030-005-1220-0000; 030-005-1530-0000; 030-010-0100-0000; 030-010-0110-0000; 030-010-0130-0000; 030-010-1220-0000; 030-010-1500-0000; 030-010-1600-0000; 030-015-0110-0000; 030-015-0130-0000; 030-015-1500-0000; 040-005-0110-0000; 040-005-0124-0000; 040-005-0130-0000; 040-005-1530-0000; 040-010-0100-0000; 040-010-0110-0000; 040-010-0120-0000; 040-010-0130-0000; 040-010-1000-0000; 050-005-0110-0000; 050-005-0122-0000; 050-005-0124-0000; 050-005-0130-0000; 050-005-0300-0000; 050-005-1100-0000; 050-005-1220-0000; 050-005-1510-0000; 050-005-1520-0000; 050-005-1530-0000; 050-005-3220-0000; 050-010-0110-0000; 050-010-0120-0000; 050-010-0130-0000; 050-010-0320-0000; 050-010-1220-0000; 050-010-1224-0000; 052-005-0110-0000; 052-005-0122-0000; 052-005-0124-0000; 052-005-0130-0000; 052-005-0320-0000; 052-005-1100-0000; 052-005-1220-0000; 052-005-1510-0000; 052-005-1520-0000; 052-005-1530-0000; 052-010-0110-0000; 052-010-0120-0000; 052-010-1224-0000; 052-010-1500-0000; 060-005-0110-0000; 060-005-0122-0000; 060-005-0124-0000; 060-005-0130-0000; 060-005-0142-0000; 060-005-0144-0000; 060-005-1220-0000; 060-005-1510-0000; 060-005-1520-0000; 060-005-1530-0000; 060-010-0100-0000; 060-010-0110-0000; 060-010-0120-0000; 060-010-0142-0000; 060-010-1220-0000; 060-010-1500-0000 The EICs are the same for Rules 4306/4320, 4307, and 4308; the three rules share a combined emission inventory.

Control Measure	Emission Inventory Codes
Rule 4308 (Boilers, Steam Generators, and Process Heaters - 0.075 to less than 2.0 MMBtu/hr)	The EICs are the same for Rules 4306/4320, 4307, and 4308; the three rules share a combined emission inventory. See Rule 4307 for the EICs.
Rule 4309 (Dryers, Dehydrators, and Ovens)	050-012-0110-0000; 050-012-0120-0000; 052-012-0110-0000; 060-012-0110-0000; 060-012-0120-0000; 310-333-0100-0000; 430-422-7078-0000; 430-424-7000-0000; 430-424-7006-0000; 430-995-7000-0000; 499-995-0000-0000; 499-995-5630-0000
Rule 4311 (Flares)	110-132-0110-0000; 110-132-0130-0000; 110-132-0136-0000; 110-132-0146-0000; 120-132-0136-0000; 130-132-0110-0000; 130-132-0130-0000; 130-132-0136-0000; 140-130-0010-0000; 310-320-0010-0000; 310-320-0110-0000; 310-320-0120-0000; 310-320-0130-0000; 310-320-0136-0000; 310-320-1600-0000; 320-320-0010-0000; 320-320-0110-0000; 320-320-0120-0000; 320-320-0130-0000; 330-320-0010-0000
Rule 4313 (Lime Kilns)	Lime kilns are not included in the CARB emissions inventory. There are no lime kilns currently operating in the Valley.
Rule 4306/4320 (Boilers, Steam Generators, and Process Heaters greater than 5.0 MMBtu/hr)	The EICs are the same for Rules 4306/4320, 4307, and 4308; the three rules share a combined emission inventory. See Rule 4307 for the EICs.
Rule 4352 (Solid Fuel Fired Boilers, Steam Generators, and Process Heaters)	010-005-0214-0000; 010-005-0218-0000; 010-005-0220-0000; 010-005-0240-0000; 010-005-0243-0000; 010-005-0254-0000; 020-005-0214-0000; 020-005-0218-0000; 020-005-0220-0000; 020-005-0230-0000; 030-005-0214-0000; 050-005-0214-0000; 050-005-0254-0000; 052-005-0212-0000; 052-005-0240-0000; 052-005-0254-0000; 060-005-0240-0000; 060-005-0243-0000; 060-005-0250-0000; 060-005-0264-0000
Rule 4354 (Glass Melting Furnaces)	410-403-5018-0012; 460-460-7025-0000; 460-460-7037-0000; 460-460-7038-0000; 460-460-7039-0000
Rule 4550 (Conservation Management Practices)	620-614-5400-0000; 620-615-5400-0000; 650-650-5400-0000; 650-651-5400-0000
Rule 4692 (Commercial Charbroiling)	690-680-6000-0000
Rule 4702 (Internal Combustion Engines)	010-040-0110-0000; 010-040-0142-0000; 010-040-1100-0000; 010-040-1200-0000; 020-040-0110-0000; 020-040-1200-0000; 030-040-0110-0000; 030-040-0124-0000; 030-040-0130-0000; 030-040-1100-0000; 030-040-1200-0000; 030-040-1210-0000; 030-040-1600-0000; 040-040-0110-0000; 050-040-0012-0000; 050-040-0110-0000; 050-040-0120-0000; 050-040-0122-0000; 050-040-0124-0000; 050-040-1100-0000; 050-040-1200-0000; 050-040-1210-0000; 050-040-1299-0000; 050-040-3220-0000; 052-040-0110-0000; 052-040-0124-0000; 052-040-0146-0000; 052-040-1100-0000; 052-040-1200-0000; 052-042-0110-0000; 052-042-1200-0000; 052-042-1200-0010; 052-042-1200-0011; 060-040-0012-0000; 060-040-0110-0000; 060-040-0120-0000; 060-040-0122-0000; 060-040-0124-0000; 060-040-0130-0000; 060-040-0142-0000; 060-040-0146-0000; 060-040-1100-0000; 060-040-1200-0000; 060-040-1210-0000; 060-995-1220-0000; 099-040-0136-0000; 099-040-1200-0000
Rule 4703 (Stationary Gas Turbines)	010-045-0110-0000; 010-045-0112-0000; 010-045-1200-0000; 020-045-0110-0000; 020-045-1200-0000; 030-045-0110-0000; 030-045-0130-0000; 030-045-1200-0000; 040-045-0134-0000; 040-045-1412-

Control Measure	Emission Inventory Codes
	0000; 050-045-0110-0000; 050-045-1200-0000; 050-045-1299-0000; 052-045-0110-0000; 052-045-0146-0000; 052-045-1200-0000; 060-045-0012-0000; 060-045-0110-0000; 060-045-0146-0000; 060-045-1200-0000; 060-045-1400-0000; 060-045-1412-0000; 060-045-1420-0000; 060-045-1450-0000
Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters)	610-600-0230-0000; 610-602-0230-0000
Rule 4902 (Residential Water Heaters)	610-608-0110-0000
Rule 4905 (Natural Gas-Fired, Fan-Type Central Furnaces)	060-020-0110-0000; 610-606-0110-0000
Rule 8011 (General Requirements)	There is no specific emissions inventory associated with Rule 8011.
Rule 8021 (Construction, Demolition, Excavation, Extraction, and Other Earthmoving Activities)	430-426-7006-0000; 630-622-5400-0000; 630-624-5400-0000; 630-626-5400-0000; 630-628-5400-0000; 630-634-5400-0000
Rule 8031 (Bulk Materials)	410-436-5800-0000; 430-436-7006-0000; 430-436-7016-0000; 430-436-7018-0000; 430-436-7078-0000; 430-995-7006-0000; 430-995-7012-0000; 430-995-7016-0000; 430-995-7018-0000; 430-995-7050-0000; 430-995-7064-0000; 430-995-7072-0000
Rule 8041 (Carryout and Trackout)	The EICs are included in Rule 8061 (Paved and Unpaved Roads).
Rule 8051 (Open Areas)	650-652-5400-0000
Rule 8061 (Paved and Unpaved Roads)	640-635-5400-0000; 640-637-5400-0000; 640-639-5400-0000; 640-641-5400-0000; 640-643-5400-0000; 645-638-5400-0000; 645-640-5400-0000; 645-644-5400-0000; 645-648-5400-0000
Rule 8071 (Unpaved Vehicle/Equipment Traffic Areas)	645-645-5400-0000; 645-647-5400-0000. The CARB Emissions Inventory database does not contain emissions data on unpaved vehicle and equipment traffic areas.
Rule 8081 (Agricultural Sources)	645-646-5400-0000

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Chapter 3

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

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TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

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 PM2.5 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 $\mu g/m^3$ annual PM2.5 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 PM2.5 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 $\mu g/m^3$ annual PM2.5 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 PM2.5 levels. Next, CARB staff identified potential control measures for each mobile source sector and the appliance sector, including an analysis of California's control program, other control measures in practice throughout the nation, control measures suggested by the public, and reconsideration of control measures that were previously considered to be infeasible (as applicable). Staff then assessed the stringency and feasibility of the potential control measures that were identified. And finally, while many of the measures identified in this analysis have already been adopted by CARB and submitted in the California SIP, additional control measures have been included in the 2022 State Strategy for the State Implementation Plan (2022 State SIP Strategy)[1] and will be commitments in the Valley's upcoming SIP for the 12 µg/m^3 annual PM2.5 standard.

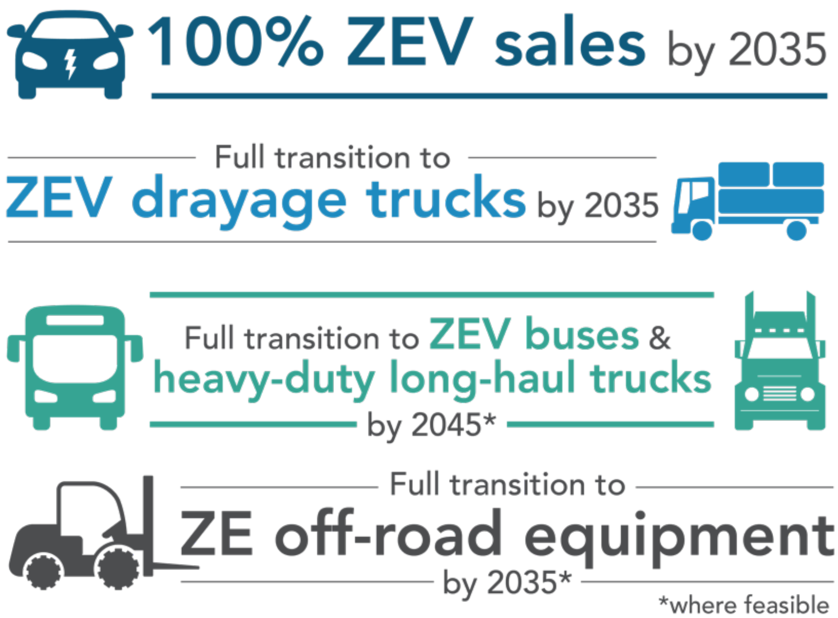
Given the severity of California's air quality challenges and the need for ongoing emission reductions, CARB has implemented the most comprehensive mobile source emissions control program in the nation. In aggregate, California's comprehensive suite of new vehicle and engine emission standards, in-use 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-79-20[2].

[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 PM2.5 challenge in that area, then U.S. EPA re-classifies the area to Serious, and establishes requirements for a second SIP submittal that must show attainment within 10 years after the area was originally designated nonattainment.
- If the Serious area cannot show attainment within 10 years, the state can request an additional five-year extension if most stringent measures are in place and the State has met their obligations for the standard.

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

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

[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 µg/m^3 annual PM2.5 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 µg/m^3 annual PM2.5 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 Required[8]

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

DEFINING MOST STRINGENT MEASURES

MSM is the level of stringency required for the 2012 Annual Standards of 12 µg/m^3. The Act defines MSM as, "any permanent and enforceable control measure that achieves the most stringent emissions reductions in direct PM2.5 emissions and/or emissions of PM2.5 plan precursors from among those control measures which are either included in the SIP for any other National Ambient Air Quality Standard (NAAQS), or have been achieved in practice in any state, and that can feasibly be implemented in the relevant PM2.5 NAAQS nonattainment area."[9]

U.S. EPA guidance indicates that MSM is inclusive of the requirements and process for determining BACM.[10] The Act defines BACM as, "any technologically and economically feasible control measure that can be implemented in whole or in part within four years after the date of reclassification of a Moderate PM2.5 nonattainment area to Serious and that generally can achieve greater permanent and enforceable emissions reductions in direct PM2.5 emissions and/or emissions of PM2.5 plan precursors from

[8] The Valley's SIP has been developed to provide the necessary elements for the for the 12 µg/m3 Annual PM2.5 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 µg/m3 Annual PM2.5 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]

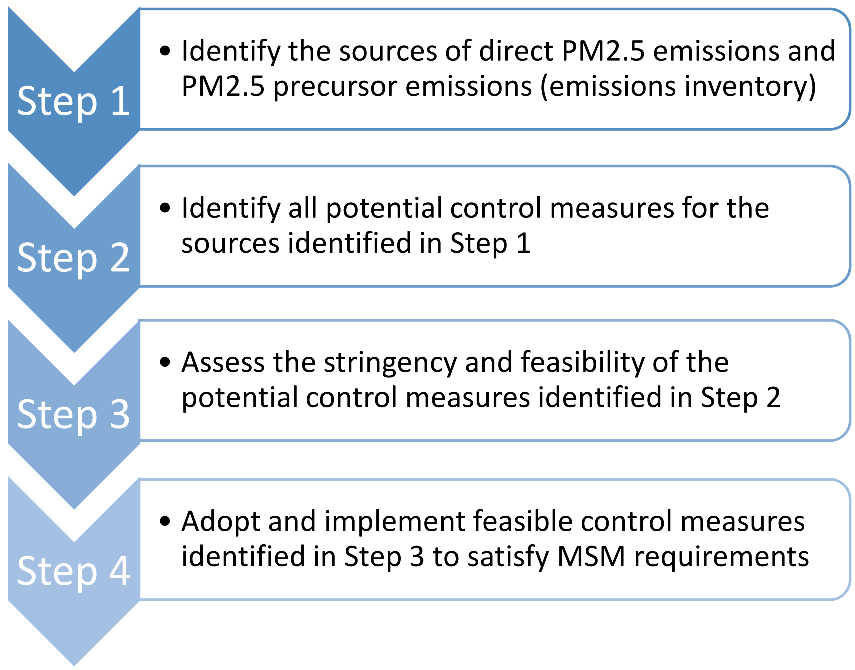
MSM is inclusive of the requirements for BACM, but with an additional step, comparing the potential MSMs identified against the measures already adopted in the area to determine if the existing measures are the most stringent.[15] Furthermore, U.S. EPA guidance defined MSM as "the maximum degree of emission 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-subchapI-partC-subparti-sec7479.htm See § 7479(3) BACT
[14] U.S. EPA 1994 "Addendum to the General Preamble" pp. 42009 -42013
[15] U.S. EPA 2001 *Final TSD for Maricopa County PM10 Nonattainment Area*. Available at https://www3.epa.gov/region9/air/phoenixpm/pdf/tsd0901.pdf
[16] U.S. EPA 1994. *Addendum to the General Preamble*, 59 FR 41998 page 42010

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.

Figure 3-2 Process for Determining MSM



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]

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

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

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

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

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

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 PM2.5 levels. Overall, mobile sources contribute to approximately 40 to 50 percent of the particles that make up PM2.5 in the Valley. These contributions come through both directly emitted PM2.5 and gaseous precursors such as NOx, the key precursor to atmospheric formation of PM2.5 in the Valley. CARB modeling demonstrated that VOC, ammonia, and SOX do not contribute significantly to ambient PM2.5 levels exceeding the NAAQS.

Residential and commercial buildings in California are the source of about 66 tpd NOx statewide due to natural gas combustion.[20] Nearly 90 percent of building NOx emissions are due to space and water heating, with the remaining 10 percent attributable to cooking, clothes drying, and other miscellaneous end uses. Space and water heating comprise nearly 90 percent of all building-related natural gas demand. Buildings also contribute to approximately 25 percent of California's GHG emissions when accounting for fossil fuels consumed onsite and through electricity demand as well as refrigerants 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 PM2.5 and NOx identified in Step 1.[21] To satisfy the Act's MSM requirements, this is a three-part process.

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[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 PM2.5 and PM2.5 precursors (i.e. NOx) 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 PM2.5 and/or NOx 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 PM2.5; [28] and
- U.S. EPA's mobile-specific control measures for PM2.5.[29]

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[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 PM2.5 SIPs[32] 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 $\mu g/m^3$ 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/sanjqnvllysip.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 µg/m^3 annual PM2.5 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 PM2.5 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 µg/m^3 Annual PM2.5 Standard (2012)
Classification Status	Serious with Extension
Type of Plan Required	MSM
Control Measure Requirements	MSM
Definition of MSM (regarding timing)	MSM: implemented in whole or in part by 5 years after the applicable attainment date for the area[37]
Attainment deadline	2030
Timeframe for Implementation	MSM if implemented ≤ 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 µg/m^3 PM2.5 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 $\mu g/m^3$ annual PM2.5 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 2022 State SIP Strategy[43] 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]

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[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 PM_{10} will eventually be dominated by non-exhaust sources.

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

Clean Miles Standard

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

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

On-Board Diagnostic (OBD) Systems

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

California's first ***On Board Diagnostics Regulation (OBD I)*** required manufacturers to monitor some of the emission control components for passenger vehicles, light- and medium- duty vehicles, starting with the 1988 model year. In 1989, CARB adopted ***OBD II***, which required 1996 and subsequent model year passenger cars, light-duty trucks, and medium-duty vehicles and engines to be equipped with second-generation OBD systems, which standardized the system and addressed the shortcomings of the OBD I requirements (OBD I requirements monitored only a few of the emission-related components on a vehicle). U.S. EPA granted CARB a waiver of preemption for the OBD II regulation in 2016.[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), NOx, CO and nonmethane HC (NMHC) that achieve a large degree of harmonization with more aggressive current European motorcycle emissions standards. CARB would also develop new evaporative emissions standards that largely harmonize with more aggressive current CARB OHRV emissions standards.

REDUCING IN-USE EMISSIONS

Inspection and Maintenance (I/M) Program

Although new vehicles sold in California are the cleanest in the world, the millions of passenger vehicles on California roads, and the increasing miles they travel each day make them our single greatest source of NOx emissions. While the new vehicles in California may start out with very low emissions, improper maintenance or faulty components can cause vehicle emission levels to sharply increase. Studies estimate that approximately 50 percent of the total emissions from late-model vehicles are excess emissions, meaning that they are the result of emission-related malfunctions. California's ***Smog Check Program*** works to ensure that the vehicles remain as clean as possible over their entire life. The Bureau of Automotive Repair (BAR) is the State agency charged with administration and implementation of the Smog Check Program. The Smog Check Program is designed to reduce air pollution from California registered vehicles by requiring periodic inspections for emission-control system problems, and by requiring repairs for any problems found. In 1998, the Enhanced Smog Check program began in which Smog Check stations relied on the BAR-97 Emissions Inspection System (EIS) to test tailpipe emissions with either a Two-Speed Idle (TSI) or Acceleration Simulation Mode (ASM) test depending on where the vehicle was registered. For instance, vehicles registered in urbanized areas received an ASM test, while vehicles in rural areas received a TSI test.

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

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

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

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

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

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

quantification of cost-effectiveness of various transportation projects. This action will accelerate the penetration of new strategies and maximize the emissions reductions from the transportation sector in the near-term. CARB would work with FHWA, the California Department of Transportation, MPOs, and air districts in pursuing this measure.

FUELS

Cleaner fuel has an immediate impact in reducing emissions from the mobile source, and thus represent an important component in reducing NOx and ROG emissions from the passenger vehicle fleet. California's stringent air quality programs treat motor vehicles and their fuels holistically (as a system, rather than as separate components). As a result, CARB's fuels programs achieve significant reductions in criteria emissions from gasoline-fueled vehicles used in California.

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

The CaRFG program has been implemented in three phases.

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

The use of cleaner-burning gasoline in the 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 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: • Prevents potential emission backsliding of ICEVs that is otherwise possible under the existing regulations by applying the exhaust and evaporative emission fleet average standards exclusively to combustion engines. Although the NMOG+NOx fleet average for light-duty vehicles remains at 30 mg/mi for MY 2026-2035, the medium-duty vehicle fleet average declines from 178 mg/mi to 150 mg/mi for Class 2b and from 247 mg/mi to 175 mg/mi for Class 3. Additionally, LEV IV eliminates the composite standard option for SFTP emissions to ensure maximum emissions control on all test cycles. • For light-duty vehicles, lowers the maximum NMOG+NOx exhaust emission rate from 160 mg/mi in MY 2025 to 70 mg/mi in MY 2029; the US06 PM emission rate from 6 mg/mi to 3 mg/mi; and evaporative running loss emission rates from 0.05 g/mi to 0.01 g/mi. For medium-duty vehicles, lower the maximum NMOG+NOx exhaust emission rate from 250 mg/mi in MY 2025 to 170 mg/mi in MY 2028 for Class 2b and from 400 mg/mi to 230 mg/mi for Class 3. • Reduces cold start emissions by applying the emission standards to a broader range of in-use driving conditions. (Starts after the vehicle engine has been shut-off for more than 12 hours are considered cold starts.) • Medium-duty vehicles with gross combined weight rating above 14,000 lbs. would also be subject to in-use test standards to capture emissions while towing.	17 States have adopted the LEV III requirements of ACC I under the provisions of Section 177: • NY, MA, VT, ME, PA, CT, RI, WA, OR, NJ, MD, DE, CO, MN, NV, VA, and NM LEV IV regulations will control emissions of criteria pollutants from the exhaust and fuel systems of conventional motor vehicles. They would apply to vehicles produced and delivered for sale in California beginning with the 2026 model year. They are more stringent than the existing federal Tier 3 standards for the same pollutants from motor vehicles for the 2025 and subsequent model years that were set by the U.S. EPA. Five other states have adopted the new LEV IV from ACC2 under Section 177: MA, OR, WA, VT, and NY
New Vehicle Standards: 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	• NY, MA, VT, ME, CT, RI, WA, OR, NJ, MD, CO, MN, NV, VA, and NM Five other states have adopted the new ZEV standards from ACC2 under Section 177: MA, OR, WA, VT, and NY There are no comparable federal standards for sales of zero-emission vehicles.
New Vehicle Standards: On-Board Diagnostic (OBD) systems requirements	California OBD II Requirements (CARB)	CARB's On-Board Diagnostic II (OBD II) Systems Requirements exceed Federal requirements in stringency. OBD II ensures that the in-use fleet continues to operate as cleanly as possible.	In practice, virtually all vehicles sold in the U.S. are designed and certified to meet California's OBD II requirements, regardless of where in the U.S. they are sold.
New Vehicle Standards: Emissions standards (Motorcycles)	California's On-Road Motorcycle Regulation (CARB) Future Measure: *On-Road Motorcycle New Emissions Standards (CARB)*	CARB's emission standards and in-use testing for on-road motorcycles (California's On-Road Motorcycle Regulation) set a Tier I and Tier II standard for 2004 and 2008 model years, respectively, for Class 3 motorcycles (280 cc or greater). California's evaporative emission limits for motorcycles exceed the stringency of any other in the nation, while exhaust emission a limits and test procedures are consistent with U.S. EPA's. The 2022 State SIP Strategy committed to the On-Road Motorcycle New Emission Standard, which will further reduce emissions from new-on-road motorcycles through the adoption of more stringent exhaust and evaporative emissions standards along with zero-emissions sales thresholds. The exhaust standards would be more stringent than current U.S. EPA standards and largely harmonized with European Union 5 (EU 5) standards. The evaporative standards would be more stringent than current U.S. EPA and EU 5 standards. This measure will also require an increase in new Zero-Emissions Motorcycle (ZEM) sales, starting at 10 percent in 2028 and progressing to 50 percent in 2035. *(Note: CARB has committed to pursue the On-Road Motorcycle New Emissions Standard measure, but this measure has yet to be proposed to the Board for approval/adoption)*	California is the only state with emission control requirements for on-road motorcycles that exceed the stringency of U.S. EPA requirements.
In-Use Emission Controls			
In-Use Emission Controls: Inspection and maintenance program (I/M program)	Smog Check Program (CARB and administered by the California Department of Consumer Affairs' Bureau of Automotive Repair)	The Inspection / Maintenance (I/M) Program testing and in-use emission controls in the 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. 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	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)	The Clean Miles Standard (CMS) regulation, which was adopted by CARB in 2021, is to reduce GHG emissions from ride-hailing services offered by transportation network companies (TNCs), on a per--passenger mile basis, and promote electrification of the fleet by setting an electric vehicle mile target. TNCs provide on-demand rides through a technology--based platform that connects passengers with drivers using personal or rented vehicles. The CMS includes two annual targets – an eVMT target as well as a GHG target in the metric of g CO2/PMT. The eVMT target would require TNCs to achieve 90 percent eVMT by 2030. The GHG target would require TNCs to achieve 0 g CO2/PMT by 2030 through electrification as well as other strategies, including increasing shared rides on their platform, improving operational efficiency (route planning and reduced mileage without passengers), and obtaining optional GHG credits. Optional GHG credits may be requested by the TNCs and approved by the CPUC for ride-hailing trips that are connected to mass transit through a verified booking process, and for investing in bicycle and sidewalk infrastructure projects that support active transportation.	CARB staff is unaware of any other state or jurisdiction with VMT reduction programs via Transportation Network Companies (TNCs).
In-Use Emission Controls: Transportation Control Measure (TCM) Reducing Vehicle Miles Travelled (VMT)	Future Measure: *Enhanced Regional Emission Analysis in SIPs (CARB)*	CARB is considering the following measures to further reduce ROG and NOx emissions from on-road motor vehicles by reducing VMT: • Change MVEB Development Process: CARB would evaluate the existing MVEB development process, including tools and the latest planning assumptions used in the analysis. Based on the review, CARB could modify the framework for developing MVEBs when considering how to address gaps in emissions reductions needed to demonstrate attainment of different NAAQS. • RACM Analysis: CARB would compile a comprehensive list of TCMs implemented or considered by federal, state, regional, and local agencies to provide more choices and new measures for potential inclusion as an enforceable measure in the SIP. This effort may also evaluate the emission reduction potential, feasibility, and cost-effectiveness of each TCM on the list, and/or provide a quantification methodology to improve and standardize the RACM analysis as part of SIPs across air districts. • Update Guidance for CMAQ and Motor Vehicle Fees: CARB would update the methodology and guidelines for estimating the cost-effectiveness of some of the most widely implemented transportation-related air quality projects using CMAQ and motor vehicle fees. Further, these guidelines would establish methods to quantify emission benefits and cost-effectiveness of new available transportation options and technologies. This update may also include critical inputs associated with emissions estimation to streamline the quantification of cost-effectiveness of various transportation projects. *(Note: CARB has committed to pursue the Enhanced Regional Emission Analysis in SIPs measure, but this measure has yet to finalized)*	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) • Areas of CA, CT, DE, the District of Columbia, IL, IN, MD, NJ, NY, PA, TX, VA, WI Other "opt in" areas for Federal RFG Phase II • Entire states: CT and DE • Portions of states: IL, KT, MD, ME, MA, MS, NH, NJ, NY, RI, TX, VA

NEW VEHICLE STANDARDS

Emission standards and ZEV Regulation

CARB's new vehicle standards for on-road light-duty vehicles are consistent with the most stringent of any other area in the nation. Due to constraints in the Act, California is the only state that can set new vehicle standards (including control measures such as emission standards, ZEV sales mandates, warranty provisions, and on-board diagnostic (OBD) requirements) that are more stringent than U.S. EPA's national standards. Other states can adopt California programs for which U.S. EPA has provided California with waivers.[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 complimentarily.

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 NOx and VOCs emissions by approximately 80 percent, relative to the former federal Phase II levels (which were set in 1995). Sulfur content in gasoline is reduced from 30 parts per million (ppm) to 10 ppm on average.

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

Beyond the Federal requirements described above, the Act also allows states to adopt unique fuel programs to meet local air quality needs, which are referred to as Boutique Fuel Programs. Most of these programs set lower gasoline volatility requirements than the federal standards, and most are effective for only part of the year. As of January 19, 2017, U.S. EPA provided as snapshot of these programs that had been approved in SIPs,[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/m³ Annual PM2.5 Standard (2012)
New Passenger Vehicle Standards		
Advanced Clean Cars (ACC) (Includes both LEV III and ZEV Program)	ongoing	MSM
Advanced Clean Cars 2 (ACC 2) (Includes both LEV IV and Amendments to the ZEV Program)	2026	MSM
Recently amended in 2022 to require that new vehicle sales are 100% ZEV by 2035, the ACC program requires increasingly stringent standards for gasoline cars and passenger trucks. The currently adopted standards and requirements, including the zero-emission requirements of ACC 1 and ACC 2, are technology-forcing and are the most stringent in the nation; further stringency would not be feasible. An accelerated timeline would also not be feasible as new car standards need years of lead time to be developed, certified, manufactured, and implemented.		
In-Use Emission Control Measures		
On-Board Diagnostics II (OBD II)	ongoing	MSM
Recently amended in 2021 to require program updates that address cold start emissions and diesel PM monitoring, many of the regulatory changes to OBD II are phased-in through 2027 to allow sufficient lead time for the necessary technological development, manufacturing, testing, certification, and implementation for the requisite hardware and software changes; accelerated timelines would not be feasible. OBD II requirements are the most stringent in the nation; further stringency would not be feasible.		
Smog Check	ongoing	MSM
Amended in 2010 to enhance program efficacy with new technologies and test methods. California Smog Check requirements are the most stringent passenger vehicle inspection and maintenance in the nation; further stringency would not be feasible.		
Control Measures to Reduce Vehicle Miles Traveled (VMT)		
Clean Miles Standard (2022 State SIP Strategy measure, adopted in 2021)	2023	MSM
Recently adopted in 2021 to set eVMT and GHG requirements for transportation network companies (TNCs). The Clean Miles Standard's zero-emissions technology requirements are the most stringent standard in the nation; further stringency would not be feasible. An accelerated timeline would also not be feasible as standards and fleet requirements need lead time to be implemented.		
Motorcycle Control Measures		
California On-Road Motorcycle Regulation	ongoing	MSM
On-Road Motorcycle New Emission Standards (2022 State SIP Strategy measure with commitment)	2025	MSM
Proposed amendments to California's on-road motorcycle program would require more stringent exhaust emissions standards that would harmonize with European standards, with a Board hearing date anticipated in 2023. Amendments may also include evaporative emissions standards and ZEM sales thresholds. With these amendments, the stringency of CARB's motorcycle program will exceed the stringency of any other U.S. jurisdiction, and will rely on recent developments in emission control technologies; further stringency would not be feasible. Accelerated timelines would also not be feasible as new standards need years of lead time for staff to evaluate feasibility, and for compliant motorcycle technologies to be developed, certified, and implemented.		
Fuels Control Measures		
California's Reformulated Gasoline (CaRFG) Phase III	ongoing	MSM
Amended in 2003 to require the removal of MTBE, and to included refinery limits and cap limits. CARB's gasoline standards and requirements are the most stringent in the world; it is not feasible to require further stringency of fuel specifications.		

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

Step 3(b) calls for an assessment of the feasibility of implementing any measure that is not included in the 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 Program[59] 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.

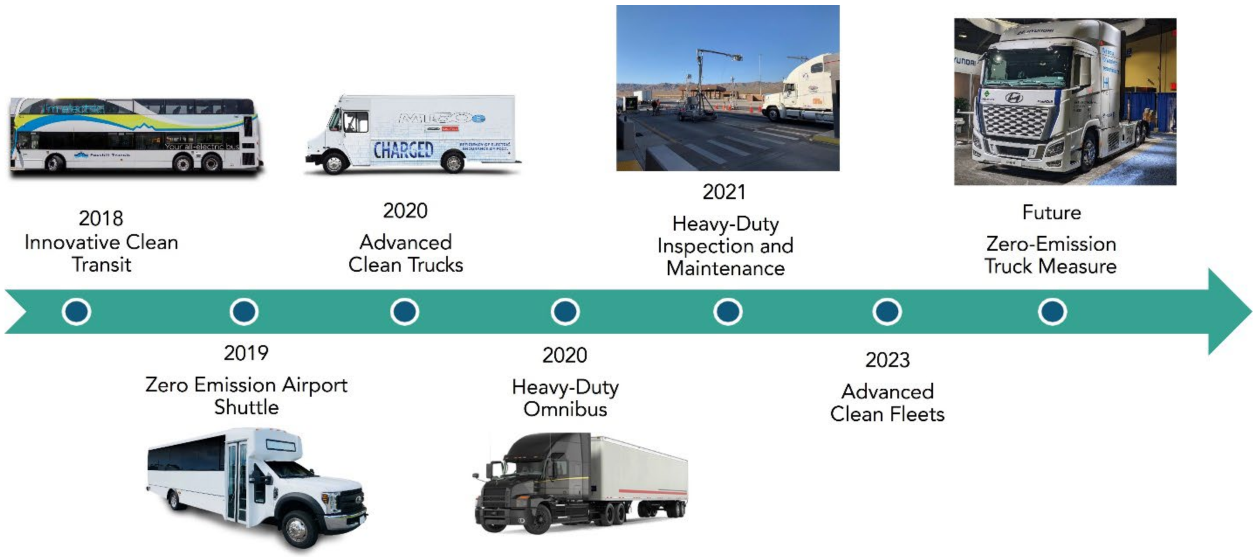
3.4.2 On-Road Medium- and Heavy-Duty Vehicles

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 NOx emissions, and are a significant source of statewide diesel PM and GHG emissions. The majority of these vehicles operate on diesel-cycle engines, especially in the higher weight classes. Gasoline and natural gas Otto-cycle spark-ignited engines are also used in heavy-duty trucks, to a lesser extent, and primarily in the lower weight classifications.

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

Through ongoing efforts, CARB has developed the most stringent and successful heavy-duty vehicle emission control program in the world. CARB has numerous programs currently in place to control emissions from medium- and heavy-duty vehicles including the Truck and Bus Regulation, Heavy-Duty Omnibus, Advanced Clean Trucks, as well as incentive programs such as the widely successful Carl Moyer Program. In addition, CARB recently adopted the Heavy-Duty Inspection and Maintenance regulation, a 2016 State SIP Strategy measure. Regulatory programs include requirements for increasingly tighter new engine standards, address vehicle idling, certification procedures, on-board diagnostics, emission control device verification, and requires accelerated turnover of the in-use fleet to cleaner, lower-emitting emission control and engine technologies. Due to the benefits of CARB's longstanding heavy-duty mobile source program, emissions in the 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 NOx 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 ≤ 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 General	California NOx Urban Buses	Federal NOx	California PM General	California PM Urban Buses	Federal PM General	Federal PM Urban Buses
1985 -86	10.7		10.7	n/a		n/a	
1987	6.0		10.7	0.60		n/a	
1988 - 89	6.0		10.7	0.60		0.60	
1990	6.0		6.0	0.60		0.60	
1991 - 92	5.0		5.0	0.25	0.10	0.25	
1993	5.0		5.0	0.25	0.10	0.25	0.10
1994 - 95	5.0	5.0 3.50 - 0.50 Optional (1995+)	5.0	0.10	0.07	0.10	0.07
1996 - 97	5.0	4.0 2.50 - 0.50 Optional	5.0	0.10	0.05* *(*0.07 in-use)*	0.10	0.05* *(*0.07 in-use)*
1998 - 03	4.0 2.50 - 0.50 Optional		4.0	0.10 0.03 – 0.01 Optional (2002+)	0.05* *(*0.07 in-use)*	0.10	0.05* *(*0.07 in-use)*
2004 - 06	2.0	0.50 - 0.01	2.0	0.10 0.03 – 0.01 Optional	0.01	0.10	0.05* *(*0.07 in-use)*
2007 - 09	0.20* *phased-in (*fleet avg ~1.2)*	0.20	0.20* *phased-in (*fleet avg ~1.2)*	0.01		0.01	
2010 - 14	0.20		0.20	0.01		0.01	
2015 - 23	0.20 0.10 – 0.02 Optional		0.20	0.01		0.01	
2024 - 26	0.050 (0.020 Optional)		0.20	0.005		0.01	
2027 - 30	0.020 (miles ≤ 435,000), and 0.035 (435,000 - 600,000 miles) (0.010 Optional)		0.035	0.005		0.005	
2031+	0.020 (miles ≤ 435,000), and 0.040 (435,000 - 800,000 miles) (0.010 Optional)		0.035	0.005		0.005	

The Omnibus Regulation implemented two key measures in the 2016 State SIP Strategy: the Low-NOx Engine Standard, and the Lower In-Use Emission Performance Level measures. The Omnibus Regulation established stringent NOx and PM engine emission standards that, when fully implemented, will be 90 percent below current levels on existing certification cycles, and lower NOx standards on new certification cycles to control emissions over a broader range of vehicle operation, including idling, low load, and highway operation. In addition, the Omnibus Regulation revised the heavy-duty in-use testing program to make it more effective in ensuring compliance with the in-use emission standards over a broader range of vehicle operation and lengthened the useful life and emissions warranty period requirements to reflect the longevity of heavy-duty vehicles.

To support the Omnibus rulemaking, CARB, in partnership with federal and local air agencies and the heavy-duty engine industry, have funded over $5 million worth of research contracts with South Research Institute (SwRI) to evaluate various engine and emission control strategies to reduce NOx emissions from heavy-duty engines by 90 percent without or with minimal GHG impacts. The results from these contracts referred to as the Stage 1,[60] Stage 2,[61] and Stage 3[62] Heavy-Duty Low NOx Programs formed the bases for supporting the Omnibus Regulation. In addition, CARB had also contracted with the National Renewable Energy Laboratory to conduct a cost analysis for compliance with CARB's proposed lower NOx exhaust emission standards on current certification test cycles and a new low-load certification test cycle, as well as cost associated with increasing the useful life and emission warranty period requirements.[63]

Optional heavy-duty engine emission standards

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

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

[60] SwRI, 2017. "Evaluating Technologies and Methods to Lower NOx Emissions from Heavy-Duty Vehicles, Final Report" https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/past/13-312.pdf
[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-VDdXMFIhU2IAWQIw.pdf
[62] SwRI, 2021. "Further development and Validation of Technologies to Lower NOx Emissions from Heavy-Duty Vehicles, Final Report" https://www.arb.ca.gov/lists/com-attach/79-hdomnibus2020-Uj4AaQB2Aj8FbAhw.pdf
[63] NREL, 2020. "On-Road Heavy-Duty Low-NOx 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 Work, New Jersey, Washington, and Oregon. 17 states, the District of Columbia, and the Province of Quebec, Canada, also have medium- and heavy-duty ZEV commitments.

Warranty Requirements and Useful Life

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

Since the 2007 model year, all on-road heavy-duty diesel vehicles and heavy-duty diesel engines have been subject to stringent PM and NOx emission standards. Manufacturers have met these standards by equipping new heavy-duty diesel engines with diesel particulate filters (DPF) for control of PM, and beginning with the 2010 model year have also included systems for controlling NOx using exhaust gas recirculation (EGR) and selective catalytic reduction systems. These emission control systems can reduce NOx emissions by more than 95 percent and PM emissions by more than 99 percent. Therefore, if these components fail, an individual engine's and vehicle's emissions can dramatically increase. It is therefore crucial that these emission control systems continue to function as designed throughout a vehicle's life to ensure emissions remain low.

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

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

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

Emissions warranties are intended to provide a level of assurance to the vehicle owner that the engine and its associated emission control systems are unlikely to experience defects in materials and workmanship that could result in the engine not performing as required. If such defects do occur during the warranty period, the manufacturer is liable for fixing them. Lengthened warranty periods may also reduce incidences of tampering and mal-maintenance. For example, there would be little incentive for a vehicle owner to tamper with the vehicle's emission control system, such as by coring out a DPF or bypassing a catalyst, when the manufacturer is obligated to pay for any defect-related repairs. Furthermore, vehicle owners would also have more of an incentive to timely perform scheduled maintenance so as not to void their lengthened warranty. Additionally, lengthened warranty periods are needed to protect heavy-duty vehicle owners from potentially high repair costs under the requirements of CARB's recent amendments to the Periodic Smoke Inspection Program (PSIP) and Heavy-Duty Vehicle Inspection Program (HDVIP), which include much stricter opacity limits intended to 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, knowns as the Engine Manufacturer Diagnostic (EMD) regulation. The EMD Regulation required manufacturers of heavy-duty engines and vehicles to implement diagnostic systems on all 2007 and subsequent MY on-road heavy-duty engines. The EMD Regulations were much less comprehensive than the OBD II regulations and were intended for heavy-duty manufacturers to achieve a minimum level of diagnostic capability. In 2005, CARB adopted ***Heavy-Duty Specific OBD Requirements (HD OBD)***, which applied to 2010 and subsequent model year heavy-duty engines and vehicles (i.e., vehicles with a gross vehicle weight rating greater than 14,000 pounds). This regulation required by 2013 that all heavy-duty engines offered for sale in California come equipped with OBD systems. U.S. EPA issued a waiver of preemption for the California 2010 Model Year Heavy-Duty Vehicle and Engine On-Board Diagnostic Standards in 2008, and has also issued two subsequent waivers for amendments CARB has made to the heavy-duty OBD requirements in later years to increase the stringency of these requirements.[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 PM2.5 and NOx emissions from existing diesel vehicles operating in California. These measures fall within three categories: measures that utilize inspections and maintenance programs in order to improve in-use emission performance levels; truck idling requirements; and fleet turnover rules.

Inspection and Maintenance (I/M) Program

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

Opacity Limits

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

To ensure that in-use heavy-duty vehicles continue to operate at their cleanest possible level CARB's 2018 amendments to the ***Periodic Smoke Inspection Program (PSIP)*** and HDVIP programs lowered the opacity limits for on-road heavy-duty trucks beyond the existing opacity limits (40 and 55 percent), which were no longer adequate to identify and require repairs of vehicles operating with damaged PM emission control components – even vehicles with heavily damaged and malfunctioning emission control systems emit exhaust at opacity levels below those opacity limits. To tighten these standards, and further control emissions form the many HD vehicles operating in California emitting excess PM emissions, staff developed lower opacity limits which reflect the current emission control technology equipped on today's HD diesel vehicles. ***The 2018 Amendments to the Periodic Smoke Inspection Program (PSIP)*** require all California-based fleets of two or more heavy-duty diesel vehicles over 6,000 pounds GVWR with engines over four years old are required to perform annual smoke opacity tests (1998 and newer diesel vehicles between 6,000–14,000 pounds GVWR subject to biennial smog check are not subject to PSIP). Allowable levels of Smoke Opacity are shown in Table 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 receival, they will have 30 calendar days to submit to CARB a passing HD I/M compliance test performed by a HD I/M tester. The type of HD I/M compliance test a vehicle will undergo depends on whether it is equipped with OBD or not. OBD-equipped vehicles are required to undergo a scan of the engine's OBD data using a CARB-validated OBD test device. Diesel vehicles and diesel hybrids with 2013 and newer model year engines have OBD systems. For alternative fuel vehicles, 2018 and newer model year engines have OBD systems. Non-OBD vehicles, i.e., those that don't meet the engine model year requirements, are required to undergo a smoke opacity test and a visual inspection of the vehicle's emissions control equipment, referred to as the Vehicle Emissions Control Equipment Inspection. Vehicles that are currently subject to PSIP must still perform their annual compliance inspections.

Starting in mid-2023, vehicle owners will be required to create owner accounts in CARB's HD I/M database, verify the vehicles in their fleets, and pay the first annual compliance fee for each vehicle. Once enforcement begins, vehicle owners that don't comply with these requirements may be cited for non-compliance and/or have their DMV vehicle registrations blocked. Upon enforcement of the requirements to establish owner accounts with vehicle information as described above, freight contractors and brokers must verify that heavy-duty vehicles they contract with for services are in compliance with the HD I/M regulation. This also includes public agencies that contract for heavy-duty truck services. Furthermore, seaport and railyard facilities must also verify compliance with the HD I/M regulation for vehicles that enter their facilities.

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

I/M periodic compliance testing, OBD equipped vehicles will be required to undergo testing four times per year. On-road agricultural vehicles and California-registered motorhomes will remain on the once per year testing frequency, even if equipped with OBD.

Idling Requirements

To reduce idling emissions from new heavy-duty diesel vehicles and emissions from auxiliary power units used as alternatives to heavy-duty vehicle idling, the Airborne Toxic Control Measure (ATCM) to Limit Diesel-Fueled Commercial Motor Vehicle Idling ***(Heavy-Duty Diesel Vehicle Idling Reduction Program)*** requires, among other things, that drivers of diesel-fueled commercial motor vehicles with gross vehicle weight ratings greater than 10,000 pounds, including buses and sleeper berth equipped trucks, not idle the vehicle's primary diesel engine longer than five minutes at any location. First adopted in July 2004 and subsequently amended, the regulation consists of new engine and in-use truck requirements and emission performance requirements for technologies used as alternatives to idling the truck's main engine. Under the new engine requirements, 2008 and newer model year heavy-duty diesel engines need to be equipped with a non-programmable engine shutdown system that automatically shuts down the engine after five minutes of idling. In 2012, U.S. EPA issued a waiver of preemption for the most recent amendments made to the Idling Reduction Program in 2006, beginning in model year 2008.[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 PM2.5 emissions to 0.01 g/bhp-hr. This can be done by repowering, retrofitting, or retiring the vehicle. Implementation of the rule started in 2007, with a compliance schedule based on the engine model year. Additionally, public agencies and utilities' fleets may be subject to requirements under the Truck and Bus Regulation.

The ***Advanced Clean Fleets Regulation***, approved by the CARB Board in April 2023, will accelerate ZEV adoption among public fleets. This regulation targets public fleets with 50 or more trucks or entities with trucks and $50 million in annual revenues. This effort is part of a comprehensive strategy to achieve a ZEV truck and bus fleet by 2045 everywhere feasible, and significantly earlier for certain well-suited market segments such as government fleets. The Advanced Clean Fleets Regulation will phase in ZEV requirements for different fleets, including requirements for State and local government fleets (including cities, counties, special districts, and other municipalities) to add only ZEVs to their fleets starting at 50 percent of new additions purchased in 2024 and 100 percent starting in 2027, or fleets may opt to phase-in ZEV requirement where a portion of the fleet must be zero-emission based on a pre-determined schedule. Small public fleets and those that are based in designated low population counties would begin with 100 percent ZEV additions starting in 2027.

Transit Agencies

Adopted in 2000, the ***Fleet Rule for Transit Agencies (Transit Fleet Rule)*** requires reductions in diesel PM and NOx emissions from urban buses and transit fleet vehicles and required future zero-emission bus purchases. Urban bus fleets were required to select either the diesel path or the alternative-fuel path. Transit agencies on the diesel path needed to demonstrate zero-emission buses, and to meet the zero-emission bus purchase requirements sooner, while agencies on the alternative-fuel path had to ensure that 85 percent of urban bus purchases were alternative fueled without a demonstration requirement. The Transit Fleet Rule was amended in 2004, and again in 2006. The 2006 amendments temporarily postponed the zero-emission bus purchase requirement (until 2011 and 2012, depending on the compliance path) and expanded the initial demonstration with a subsequent advanced technology demonstration phase. In 2009, CARB staff provided a technology update to the Board on the commercial readiness of zero-emission buses, and received Board direction to research and develop commercial readiness metrics to be used as criteria to initiate the zero-emission bus purchase requirement, and to conduct a technology assessment on the readiness of zero-emission bus technologies. U.S. EPA granted CARB a waiver of preemption for the Fleet Rule for Transit Agencies in 2013.[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 CARBs ATCM limiting school bus idling raising the minimum penalty for a violation of this rule from $100 to $300. The bill also clarifies local air district authority to enforce the State's school bus idling program. SB 124 became effective on January 1, 2010, and the existing regulation was revised to reflect this change.

While California's idling requirements for school buses are the most stringent in the nation, California does not currently have any proposed or current regulations that require electrification of the school bus fleet. New York State's enacted fiscal year 2022-2023 budget established a nation-leading commitment for all new school buses purchased to be zero emission by 2027 and all school buses in operation to be electric by 2035,[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 inhibit the performance of (at the time of CARB's ULSD rulemaking, the average sulfur content of California diesel was approximately 140 ppmw).

Beyond the current fuels control program, CARB committed in the 2016 State SIP Strategy to develop a ***Low Emission Diesel*** Measure that will require diesel fuel providers to steadily decrease criteria pollutant emissions from their diesel products. The use of low-emission diesel in on-road vehicles and off-road equipment will reduce tailpipe NOx and PM emissions, in addition to other criteria pollutants. Some studies carried out to date on hydrotreated vegetable oil have reported NOx emission reductions of 6 percent to 25 percent and PM emission reductions of 28 percent to 46 percent, depending on the types of fuels, drive cycles tested, and diesel engines used. This standard is anticipated to both increase consumption of low-emission diesel fuels, and to reduce emissions from conventional fuels. This measure is anticipated to provide NOx benefits predominately from legacy (pre-2010) on-road heavy-duty vehicles, off-road engines, stationary engines, portable engines, marine vessels and locomotives, as well as NOx and diesel PM benefits in potentially all model year off-road engines, stationary engines, portable engines, marine vessels and locomotives. Interstate vehicles, even those registered out-of-State but operating on CARB diesel blended with low-emission diesel, are also anticipated to provide emission reduction benefits.

Controlling Criteria Emissions from Renewable Fuels

The ***Low Carbon Fuel Standard (LCFS) and Alternative Diesel Fuel (ADF) Regulations,*** as amended in 2014, work together to reduce the carbon intensity of the California fuel supply. The regulations also limit criteria emissions from alternative fuels and/or alternative fuel mix blends (a mix of fuels made from renewable feedstocks, which are then blended with conventional gasoline or diesel).

STEP 2(B): OTHER STATES' AND NONATTAINMENT AREAS' ON-ROAD MEDIUM- AND HEAVY-DUTY CONTROL MEASURES

Table 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)	The Advanced Clean Truck Regulation is part of a holistic approach to accelerate a large-scale transition of zero-emission medium-and heavy-duty vehicles from Class 2b to Class 8. The regulation has two components including a manufacturer sales requirement, and a reporting requirement: • Zero-emission truck sales: Manufacturers who certify Class 2b-8 chassis or complete vehicles with combustion engines would be required to sell zero-emission trucks as an increasing percentage of their annual California sales from 2024 to 2035. By 2035, zero-emission truck/chassis sales would need to be 55% of Class 2b – 3 truck sales, 75% of Class 4 – 8 straight truck sales, and 40% of truck tractor sales.	CARB is leading the nation on the development and penetration of on-road heavy-duty ZEVs through the Advanced Clean Trucks Regulation Reg teams – what other States have adopted / are in the process of adopting the ACT regulation? MA, NJ, NY, OR, VT, & WA have adopted … others? ME has begun rulemaking process, where do CO, CT, DC, HI, MD, NC, OR, PA, RI, VA, stand? The following states have adopted ACT: MA, NJ, NY, OR, VT, and WA. Some other states are considering adoption. NC has an executive order directing state officials to begin adopting the ACT rule.
New Vehicle and Engine Standards: Heavy-duty internal combustion engine emission standards (mandatory standards)	Mandatory Heavy-Duty vehicle and engine emission standards (CARB and U.S. EPA) Heavy-Duty Omnibus Regulation (CARB)	California's emissions standards for on-road heavy-duty vehicles are the most stringent in the nation. CARB's current emission standards for heavy-duty engines (NOx and PM) are set at the same level of stringency as Federal standards for MY 2010– 2023 engines. With the Heavy-Duty Omnibus regulation, CARB has further increased the stringency of controls for MY 2024 and subsequent engines by lowering California NOx and PM emission standards on existing regulatory cycles as well as a new NOx standard on a new low load certification cycle. The NOx standards would be cut to about 75 percent below current standards beginning in 2024 and 90 percent below current standards in 2027. The limits are for MY 2024 - 2026: • NOx: 0.050 g/bhp-hr • PM: 0.005 g/bhp-hr For MY 2027-2030:	No other state has more stringent exhaust emission standards than California. Current CARB and U.S. EPA limit exhaust emissions to same levels (MY 2010 – 2023) • NOx: 0.20 g/bhp-hr • PM: 0.01 g/bhp-hr Five other States have also adopted the Omnibus regulation (MA, NY, OR, WA and VT). In MYs 2024-2026, California's standards will exceed the stringency of Federal standards, which are currently at 0.20 g/bhp-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.

<table>
<thead>
<tr><th>Type of Control Measure</th><th>Most Stringent Control Program Identified</th><th>Summary of Findings from Analysis</th><th>Other Jurisdiction(s) Analyzed</th></tr>
</thead>
<tbody>
<tr><td colspan="4">On-Road Heavy-Duty Vehicles</td></tr>
<tr><td></td><td></td><td>

NOx: 0.020 g/bhp-hr @ miles ≤ 435,000
0.035 g/bhp-hr @ 435,000 < miles ≤ 600,000
PM: 0.005 g/bhp-hr

For 2031 and Subsequent MYs:

NOx : 0.020 g/bhp-hr @ miles ≤ 435,000
0.040 g/bhp-hr @ 435,000 < miles ≤ 800,000
PM: 0.005 /bhp-hr

In December 2022, U.S. EPA finalized new emissions standards for federally-certified vehicles beginning in 2027, though these are less stringent than those included in CARB’s Heavy-Duty Omnibus Regulation: For MY 2027 and later years, federal certification limits will be set to 0.035 g/hp-hr for NOx and 0.005 g/hp-hr for PM
</td><td></td></tr>
<tr><td>New Vehicle and Engine Standards: Optional heavy-duty internal combustion engine emission standards</td><td>Optional Heavy-Duty Low NOx Emission Standards (CARB)

Omnibus Regulation (CARB)</td><td>CARB’s optional standards accelerate the pace of innovation and development of cleaner engine technologies by certifying engines that go beyond the stringency of existing standards. Starting in 2015, engine manufacturers could choose to certify to three optional NOx emission standards of 0.1 g/bhp hr, 0.05 g/bhp-hr, and 0.02 g/bhp-hr (i.e., 50 percent, 75 percent, and 90 percent lower than the existing mandatory standard of 0.2 g/bhp-hr). Together with the mandatory standards that harmonize with federal emission requirements, this program makes California’s suite of HD engine emission controls the most stringent in the nation.

The Heavy-Duty Omnibus Regulation will lower the optional Low-NOx Emission Standards to 0.020 g/bhp-hr for MY 2024-26 and to 0.010 g/bhp-hr for MY 2027 and later.</td><td>California is the only state with optional exhaust emission standards for heavy-duty engines that exceed the stringency of U.S. EPA requirements.</td></tr>
<tr><td>New Vehicle and Engine Standards: Warranty Requirements and Useful Life</td><td>California Emission Control System Warranty Regulations and Maintenance Provisions (CARB)

Omnibus Regulation (CARB)</td><td>For Model Years 2022 and later, U.S. EPA warranty provisions cover 100,000 miles, or 5 years / 3,000 hours, for Class 4 – 8 trucks; California’s more stringent warranty provisions cover:

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

CARB Useful Life:
<table>
<tr><th 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>
<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>
</table>
</td><td>Currently, no other state has more stringent warranty requirements than California. California is the only state with the authority to initially adopt and enforce emission standards and test procedures for new motor vehicles and new motor vehicle engines that are more stringent than federal emission standards and test procedures.

For MY 2022 – 2026, CARB’s warranty requirements are more stringent than Federal standards, and California’s useful life requirements align with federal requirements. Under the 2021 Omnibus Regulation, California warranty and useful life requirements are at least as stringent as federal requirements for My 2027 – 2031+.</td></tr>
</tbody>
</table>

<table>
<tr><th>Type of Control Measure</th><th>Most Stringent Control Program Identified</th><th>Summary of Findings from Analysis</th><th>Other Jurisdiction(s) Analyzed</th></tr>
<tr><td colspan="4">On-Road Heavy-Duty Vehicles</td></tr>
<tr><td></td><td></td><td>
<table>
<tr><td>2027–2030</td><td>190,000 miles 12 years</td><td>270,000 miles 11 years</td><td>600,000 miles
11 years
30,000 hours</td><td>155,000 miles
12 years</td></tr>
<tr><td>2031 and subsequent model years</td><td>270,000 miles
15 years</td><td>350,000 miles
12 years</td><td>800,000 miles
12 years
40,000 hours</td><td>200,000 miles
15 years</td></tr>
</table>
For older MY trucks and engines, both U.S. EPA and CARB require that heavy-duty vehicles meet emission standards throughout their useful life periods of 5 years / 100,000 miles (GVWR > 14,000 lbs.)</td><td></td></tr>
<tr><td>New Vehicle and Engine Standards:
OBD Requirements</td><td>Heavy-Duty OBD (CARB)</td><td>CARB and federal OBD regulations for heavy-duty vehicles generally align for MY2013 and newer engines, although CARB's program has been amended to be more stringent than U.S. EPA's for certain vehicle types. California OBD requirements are overall at least as stringent as applicable federal requirements. California OBD fault detection requirements are at least as stringent if not more stringent than U.S. EPA requirements. However in 2022, U.S. EPA updated their OBD requirements applicable to 2027 and subsequent model years to delete some California requirements and add some emission control system data parameters to be provided on demand and in the driver display.</td><td>No other state has more stringent OBD requirements than California</td></tr>
<tr><td colspan="4">In-Use Emission Controls</td></tr>
<tr><td>In-Use Emissions Controls:
I/M program (opacity limits)</td><td>Periodic Smoke Inspection Program (PSIP) (CARB)</td><td>California's in-use emission controls including opacity limits are the most stringent in the nation. The 2018 Amendments to the Periodic Smoke Inspection Program (PSIP) require all California-based fleets of two or more heavy-duty diesel vehicles over 6,000 pounds GVWR with engines over four years old are required to perform annual smoke opacity tests (1998 and newer diesel vehicles between 6,000–14,000 pounds GVWR subject to biennial smog check are not subject to PSIP).

Allowable levels of Smoke Opacity are shown below:
<table>
<tr><td colspan="2">Engines Equipped with a Diesel Particulate Filter (DPF)</td></tr>
<tr><td colspan="2">5% Opacity Limit</td></tr>
<tr><td colspan="2">Pre-2007 Model Year (MY) Engines without a DPF</td></tr>
<tr><td>1997– 2006 MY Engines</td><td>20% Opacity Limit</td></tr>
<tr><td>1991–1996 MY Engines</td><td>30% Opacity Limit</td></tr>
<tr><td>Pre-1991 MY Engines</td><td>40% Opacity Limit</td></tr>
<tr><td colspan="2">Engines Equipped with a Level 2 Verified Diesel Emission Control Strategy (VDECS)</td></tr>
<tr><td colspan="2">20% Opacity Limit</td></tr>
<tr><td colspan="2">Two-Engine Cranes Driven by a non-DPF Off-Road Engine</td></tr>
<tr><td colspan="2">40% Opacity Limit</td></tr>
</table></td><td>New Jersey's opacity limits range from 40% - 20%. California's in-use emission controls, including opacity limits, are the most stringent in the nation.</td></tr>
<tr><td>In-Use Emissions Controls:</td><td>Heavy-Duty Vehicle Inspection Program (HDVIP) (CARB)</td><td>California's in-use testing program (including the HD I/M, HDVIP and PSIP regulations) is the most stringent in the nation, with further increases in</td><td>Three other states also test OBD in heavy-duty vehicles (MA, NJ, and WI), but none aside from California are currently enforcing on OBD scans for</td></tr>
</table>

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
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: • 2 minute restrictions, no exemptions: Philadelphia, PA • 2 minute restrictions, some exemptions: Salt Lake City and Salt Lake County, UT • 3 minute restrictions, some exemptions: CT, DC, City of Ketchum (ID), New York City (NY), the Village of Larchmont (NY), the Village of Mamaroneck (NY), the County of Westchester (NY), Park City (UT), and the City of Birmingham (VT) Areas with less stringent time limits: • 3 minute restrictions, some exemptions DE, Chicago (IL), NJ, Town of Mamaroneck (NY), and Rockland County (NY)
In-Use Emissions Controls:	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: *Zero-Emission Trucks Measure (CARB)*	comprehensive and stringent mandatory heavy-duty fleet turnover rule in the nation, affecting approximately one million inter- and intra-state on-road diesel vehicles. The regulation applies to nearly all privately or federally owned diesel-fueled trucks and buses > 14,000 lbs., GVWR, including on-road and off-road agricultural yard goats, cargo handling equipment, drayage trucks, solid waste collection vehicles, and school buses. Its phased-in requirements mandate diesel particulate filters in early years, eventually requiring vehicles to fully upgrade to newer, cleaner engines that meet MY 2010 engine equivalent emissions levels when fully implemented in 2023. Approved by CARB in April 2023, the Advanced Clean Fleets Regulation accelerates ZEV adoption in the medium-to heavy-duty sectors and for light-duty package delivery trucks by setting zero-emission requirements for fleets. This regulation targets drayage trucks, public fleets, and other high priority fleets with 50 or more trucks or entities with trucks and $50 million in annual revenues. This effort is part of a comprehensive strategy to achieve a ZEV truck and bus fleet by 2045 everywhere feasible, and significantly earlier for certain well-suited market segments such as last mile delivery, drayage, and government fleets. The regulation will phase in ZEV requirements for different fleets, including components as follows: • Beginning January 1, 2024, all additions to High Priority and Federal fleets must be ZEVs, and all combustion vehicles must be removed from the California fleet at the end of their useful life, or fleets may opt to phase-in ZEV requirement where a portion of the fleet must be zero-emission based on a pre-determined schedule. • State and local government fleets including cities, counties, special districts, and other municipalities would be required to add only ZEVs to their fleets starting at 50 percent of new additions in 2024 and 100 percent starting in 2027 or fleets may opt to phase-in ZEV requirement where a portion of the fleet must be zero-emission based on a pre-determined schedule. Small public fleets or those that are based in designated low population counties would begin with 100 percent ZEV additions starting in 2027. • Beginning January 1, 2024, any truck added to drayage service would need to be a ZEV. All drayage trucks entering seaports and intermodal railyards would be required to be zero-emission by 2035; and • 100 percent of medium- and heavy-duty vehicle sales in California would be zero-emissions starting in 2036. Under the recently-approved regulation and the ACT regulation, the number of medium- and heavy-duty ZEVs operating in California will be about 1.7 million by 2045. The future Zero-Emission Trucks measure would accelerate the number of zero-emissions (ZE) trucks beyond existing measures (including the	fleet rule affecting nearly the entire on-road diesel fleet No other state has zero-emission requirements for heavy-duty vehicle fleets

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
		Advanced Clean Fleets regulation). This measure is anticipated to be implemented through one of two potential options: • Option A would use market signal tools, if given authority to implement differentiated registration fees, restrictions or fees for heavy-duty combustion trucks entering low/zero-emission zones, and/or indirect source rules to establish ZE zones by 2035. • Option B would likely be pursued if CARB is unable to implement the strategies and/or if new authorities outlined in Option A do not come to fruition. If so, CARB may need to implement an inflexible requirement for all fleets to phase-in ZEVs and to remove legacy trucks from service in California. *(Note: CARB has committed to pursue the Zero-Emission Trucks measure, but this measure has yet to be proposed to the Board for approval/adoption)*	
In-Use Emissions Controls: Fleet Rules (Drayage Trucks)	Truck and Bus Regulation (CARB) Advanced Clean Fleets Regulation (CARB)	California's in-use emission controls for drayage trucks are the most stringent in the nation. The Truck and Bus Regulation requires 2010 Model Year or newer engines at ports and rail yards starting in 2023. Approved by CARB in April 2023, the Advanced Clean Fleets (ACF) Regulation, CARB is further strengthening emission controls for drayage fleets; all drayage trucks entering seaports and intermodal railyards would be required to be zero-emission by 2035; ACF controls drayage emissions through three main components: • Zero-emission drayage truck requirements Drayage trucks will be required to start transitioning to zero-emission technology beginning in 2024, with full implementation by 2035 • Drayage Truck Registration Requirements All drayage trucks intending to begin or continue operations at a California seaport or intermodal railyard must be registered with CARB. Beginning in 2035, all trucks in the CARB Online System will be required to be zero-emission. • Removing Combustion-Powered Drayage Trucks from Service Non-zero-emission (legacy) drayage trucks with a 2010 or newer model year engine may register in the CARB Online System on or before January 1, 2024,. Beginning in 2024, all legacy drayage trucks must visit a seaport or intermodal railyard at least once each year to remain in the CARB Online System. Legacy drayage trucks 12 years old must begin reporting their mileage annually in 2025 and, can remain in the system until they reach their minimum useful life (either 800,000 miles or the engine is older than 18 years, whichever comes first). Beginning in 2025, legacy drayage trucks will be removed from the CARB Online System if they did not meet the annual visit requirement, OR if they have exceeded their minimum useful life requirements.	No other jurisdiction mandates more stringent fleet requirements for drayage trucks.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
In-Use Emissions Controls: Fleet Rules (Solid Waste Collection Vehicles)	Solid Waste Collection Vehicle Regulations (CARB) Truck and Bus Regulation (CARB) Advanced Clean Fleets Regulation (CARB)	California's in-use emissions controls for solid waste collection vehicles (SWCVs) are the most stringent in the nation. Compared to New York City's program, CARB's Solid Waste Collection Vehicles regulation limits PM emissions at approximately the same level of stringency. However, SWCV's with 2007-2009 engines were also subject to more stringent 2010 engine requirements under Truck and Bus, however, the overall level of emission controls are more stringent in California than any other jurisdiction. Approved by CARB in April 2023, the Advanced Clean Fleets Regulation accelerates ZEV adoption among solid waste collection vehicles. This regulation targets all state and local government fleets and high priority fleets with 50 or 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.	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).
In-Use Emissions Controls: Fleet Rules (Public fleets)	Public Agency and Utility Regulation (CARB) Truck and Bus Regulation (CARB) Advanced Clean Fleets Regulation (CARB)	California's in-use emissions controls for public fleets are the most stringent in the nation. CARB's Public Agency and Utility Regulation requires similar stringency in PM emissions limits as the Boston, MA program; because some utility fleets are also subject to more stringent requirements under Truck and Bus, the overall level of emission controls are more stringent in CA than any other jurisdiction. Approved by CARB in April 2023, the Advanced Clean Fleets Regulation accelerates ZEV adoption among public fleets. This regulation targets all public fleets in California. This effort is part of a comprehensive strategy to achieve a ZEV truck and bus fleet by 2045 everywhere feasible, and significantly earlier for certain well-suited market segments such as last mile delivery, drayage, and government fleets. The regulation will phase in ZEV requirements for different fleets. State and local government fleets – including cities, counties, special districts, and other municipalities – would be required to add only ZEVs to their fleets starting at 50 percent of new purchases in 2024 and 100 percent starting in 2027 or fleets may opt to phase-in ZEV requirement where a portion of the fleet must be zero-emission based on a pre-determined schedule. Small public fleets and those that are based in designated low population counties would begin with 100 percent ZEV additions starting in 2027.	The city of Boston (MA) requires by 2018 all pre-2007 diesel vehicles and equipment not previously retrofit to be controlled to achieve emission reductions of at least 85 percent (approximately equivalent to the 2007 PM standard of 0.01 g/bhp-hr). Comparatively, CARB limits are set equivalent to the 2007 MY standard of 0.01 g/bhp-hr for engine MY 1960 or newer, GVWR > 14,000 lbs.
In-Use Emissions Controls: Fleet Rules (Transit fleets)	Transit Fleet Rule (CARB) Innovative Clean Transit Regulation (CARB)	California's in-use emission controls for transit vehicles are the most stringent in the country. The Transit Fleet Rule requires emission reductions (PM and NOx) from urban buses and transit fleet vehicles, and required future zero-emission bus purchases.	No other jurisdiction mandates more stringent fleet requirements for transit fleets.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
		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.	
In-Use Emissions Controls: Fleet Rules (Last mile delivery trucks)	Truck and Bus Regulation (CARB) Advanced Clean Fleets Regulation (CARB)	California's in-use emission controls for last mile delivery vehicles (Class 3-7 heavy-duty delivery trucks used to deliver freight from warehouses and distribution centers to the final point of sale or use) are the most stringent in the nation. Truck and Bus requires MY 2010 or equivalent engines for Class 4 – 8 engines by 2023. 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.	No other jurisdiction mandates more stringent fleet requirements for last mile delivery trucks.
In-Use Emissions Controls: Fleet Rules (Airport shuttle buses)	Truck and Bus Regulation (CARB) Zero-Emission Airport Shuttle Bus Regulation (CARB)	California's in-use emission controls for airport shuttle buses (vehicles used to transport passengers between car parking lots, airport terminals, and airport car rental facilities) are the most stringent in the nation. The Truck and Bus Regulation requires MY 2010 or equivalent engines by 2023. The Zero-Emission Airport Shuttle Bus Regulation requires airport shuttle operators to transition to 100 percent zero-emission vehicle (ZEV) technologies. Airport shuttle operators must begin adding zero-emission shuttles to their fleets in 2027, and complete the transition to ZEVs by the end of 2035. The regulation applies to airport shuttle operators who own, operate, or lease vehicles at any of the 13 California airports regulated under this rule (regulated airports), including the Fresno Yosemite International Airport.	No other jurisdiction mandates more stringent fleet requirements for airport shuttle buses.
In-Use Emissions Controls: Fleet Rules (School Buses)	Truck and Bus Regulation (CARB) School Bus Idling Airborne Toxic Control Measure (CARB) Omnibus Regulation (CARB) School Bus Incentive Program (CARB)	California's in-use emission controls for school buses are among the most stringent in the nation. The Truck and Bus regulation requires that all school buses are equipped with PM filters. Since 2003, California has also limited bus and vehicle idling time near schools or at school bus destinations through the School Bus ATCM, reducing emissions from >26,000 school buses operating daily at or near schools. Under the Omnibus Regulation, idling limits for diesel heavy-duty vehicles will be reduced from 30 g/hr currently to 10 g/hr in MY 2024 and to 5 g/hr in MY 2027. CARB has also used incentive funds as a key component of the strategy to reduce emissions from the school bus fleet. Over the past two decades,	Colorado (CO) controls emissions from school buses through a School Bus Retrofit Program funded by DERA Grants from U.S. EPA. This voluntary program began in 2009, and controls PM emissions through retrofits. CARB staff is unaware of any other jurisdictions that mandate retrofits. New York State requires all new school buses purchased to be zero emission by 2027, and all school buses in operation to be electric by 2035.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
On-Road Heavy-Duty Vehicles			
		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.	
Fuels Programs			
Fuels Standards: Diesel Standards	CARB Diesel Fuel Regulations and Ultra Low Sulfur Diesel (CARB) Future Measure: *Low Emission Diesel measure (CARB)*	California's fuel standards for diesel are the most stringent in the nation. CARB Diesel Fuel Regulations include stringent requirements for fuel mixture specifications for aromatic hydrocarbons and sulfur, and have establish a lubricity standard and applies to sales of fuel used in on-road vehicles and off-road vehicles and locomotives in California. CARB's ULSD program reduces NOx and PM emissions significantly relative to U.S. EPA requirements, providing approximately 7 percent more NOx reductions and 25 percent more dPM reductions than federal diesel. CARB is anticipated to further increase the stringency of controls on criteria pollutant emissions diesel products. *(NOTE: CARB has committed to pursue the Low Emission Diesel measure, but it has not yet been proposed to the Board for approval/adoption.)*	No state requires cleaner burning diesel than California. The California diesel fuel regulations exceed federal requirements in stringency. CARB staff are aware of only one other state, Texas, who has a boutique diesel fuel program that is approved into the SIP. An independent analysis of The Texas Low Emission Diesel program (TxLED) showed that the TxLED fuel emissions performance does not provide as significant of emission reduction benefits as the California specifications.
Fuels Standards: Alternative Fuel Standards (Diesel substitutes)	Low Carbon Fuel Standard (CARB) Alternative Diesel Fuel Regulation (CARB)	California's fuel standards for diesel substitutes are the most stringent in the nation. The Low Carbon Fuel Standard and Alternative Diesel Fuel regulations work together to reduce the carbon intensity of the California fuel supply while requiring limits on criteria emissions from alternative fuels and/or alternative fuel mix blends.	No other state has set as stringent of criteria emission requirements on alternative fuels and alternative fuel blends than California. For low carbon fuel/clean fuel programs: • Oregon, and Washington have low carbon fuel standard programs, California participates in the Pacific Coast Collaborative with these states, and British Columbia. • Other states and countries that are considering a clean fuel regulation: NY, MI, MN, NM, VT, IL, MA.

NEW HEAVY-DUTY VEHICLE AND ENGINE STANDARDS

Heavy-duty engine emission standards

CARB's truck engine standards for on-road heavy-duty engines are consistent with the most stringent of any other area in the nation. CARB's current heavy-duty engine emission standards (MY 2010 - 2023) set exhaust emission standards for PM2.5 at 0.01 g/bhp-hr and NOx at 0.20 g/bhp-hr. This aligns with the applicable federal standards set by U.S. EPA, which are also set at the same levels of stringency.[72]

With the adoption and implementation of the Heavy-Duty Omnibus Regulation, CARB will further increase the stringency of these requirements to reduce NOx exhaust emissions standards to levels 90 percent lower than the current mandatory standard (for MY 2027 – 2030, mandatory emissions standards will be set to 0.020 g/bhp-hr at miles ≤ 435,000, and 0.035 g/bhp-hr at 435,000 - 600,000 miles). Massachusetts, New York, Oregon, Washington, and Vermont have also committed to adopt CARB's Omnibus Regulation. CARB's standards will exceed the stringency of Federal standards in MY 2024 – 2031.

In December 2022, U.S. EPA finalized new emissions standards for federally-certified vehicles beginning in 2027, though these are less stringent than those included in CARB's Heavy-Duty Omnibus Regulation: For MY 2027 and later years, federal certification limits will be set to 0.035 g/hp-hr for NOx and 0.005 g/hp-hr for PM.

In December 2022, U.S. EPA finalized their regulation, "Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards", which sets stronger NOx emission standards for MY 2027 and later heavy-duty vehicles and engines. For MY 2027 and later years, federal limits will be set to 0.05 g/bhp-hr for NOx and 0.005 g/bhp-hr for PM. Like the California standards, the new federal standards will also require lower NOX emissions over a much wider range of testing conditions both in the laboratory and when engines are operating on the road. Further, the regulation includes longer useful life periods, as well as significant increases in the emissions-related warranty periods.

As most Class 7 and 8 vehicles operating in California have been originally purchased outside of the State and are thus covered by U.S. EPA, rather than CARB standards, federal action is critical to achieving the needed emission reductions for the 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-NOx 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?Dockey=P100O9ZZ.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]

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[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 PM2.5 emissions to 0.01 g/bhp-hr. This can be done by repowering, retrofitting, or retiring the vehicle. Implementation of the rule started in 2007, with a compliance schedule based on the engine model year. Comparatively, CARB's Public Agency and Utility Regulation requires similar stringency in PM emissions limits as the Boston, MA program; because some utility fleets are also subject to more stringent requirements under the Truck and Bus Regulation, the overall level of emission controls are more stringent in California than any other jurisdiction.

Additionally, the Advanced Clean Fleets Regulation will phase in ZEV requirements for public fleets in California. State and local government fleets – including cities, counties, special districts, and other municipalities – would be required to add only ZEVs to their fleets starting at 50 percent of new purchases in 2024 and 100 percent starting in 2027, or fleets may opt to phase-in ZEV requirement where a portion of the fleet must be zero-emission based on a pre-determined schedule. Small public fleets and those that are based in designated low population counties would begin with 100 percent ZEV additions starting in 2027.

Transit Fleets

California's in-use emission controls for transit vehicles are the most stringent in the country. CARB's Transit Fleet Rule requires emission reductions (PM and NOx) from urban buses and transit fleet vehicles and required future zero-emission bus purchases. Additionally, the Innovative Clean Transit Regulation requires all public transit agencies to gradually transition to a 100 percent ZEB fleet. Beginning in 2029, 100 percent of new purchases by transit agencies must be ZEBs, with a goal for full transition by 2036. No other jurisdiction mandates more stringent fleet requirements for transit fleets.

Last Mile Delivery Trucks

California's in-use emission controls for last mile delivery vehicles (Class 3-7 heavy-duty delivery trucks used to deliver freight from warehouses and distribution centers to the final point of sale or use) are the most stringent in the nation. Truck and Bus requires MY 2010 or equivalent engines by 2023. Additionally, the Advanced Clean Fleets Regulation accelerates ZEV adoption in the medium- to heavy-duty sectors and for light-duty package delivery trucks by setting zero-emission requirements for high priority fleets with 50 or more trucks or entities with trucks and $50 million in annual revenues. The regulation will phase in ZEV requirements for different fleets, resulting in 100 percent of medium- and heavy-duty vehicle sales in California being zero-emissions starting in 2036. No other jurisdiction mandates more stringent fleet requirements for last mile delivery trucks.

Airport Shuttle Buses

California's emission controls for airport shuttle buses (vehicles used to transport passengers between car parking lots, airport terminals, and airport car rental facilities) are the most stringent in the nation. The Truck and Bus Regulation requires MY 2010 or equivalent engines by 2023. Additionally, the Zero-Emission Airport Shuttle Bus Regulation requires airport shuttle operators to transition to 100 percent ZEV technologies. Airport shuttle operators must begin adding zero-emission shuttles to their fleets in 2027, and complete the transition to ZEVs by the end of 2035. The Regulation applies to airport shuttle operators who own, operate, or lease vehicles at any of the 13 California airports regulated under this rule (regulated airports), including the Fresno Yosemite International Airport. No other jurisdiction mandates more stringent fleet requirements for airport shuttle buses.

School Buses

Colorado controls emissions from school buses through a School Bus Retrofit Program funded by DERA Grants from U.S. EPA. This program began in 2009, and reduces emissions of diesel exhaust by retrofitting school buses with proven emissions-reduction technologies, including diesel-oxidation catalysts, engine preheaters and closed-crankcase filtration systems. Comparatively, California's Truck and Bus regulation requires that all privately and publicly owned school buses are equipped with diesel PM filters. California also limits bus and vehicle idling time near schools or at school bus destinations through the School Bus ATCM. It has been in effect since 2003 and reduces emissions from more than 26,000 school buses that operate daily at or near schools. The School Bus ATCM targets school buses, school pupil activity buses, youth buses, paratransit vehicles, transit buses, and heavy-duty commercial motor vehicles that operate at or near schools.

Additionally, CARB's School Bus Incentive Program has invested over $1.2 billion to date to clean up old, higher-polluting school buses. The California Legislature recently appropriated an additional $1.8 billion for zero-emission school buses and associated charging infrastructure over the next five years. Over the last twenty years, the total $1.2 billion statewide investment made, including $255 million invested in school bus cleanup over the past year alone, has supported about 1,800 zero-emission school buses. More than 560 of those buses are already on California roadways, with 327 in the State's most pollution-burdened communities.[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/m³ Annual PM2.5 Standard (2012)
New Heavy-Duty Vehicle Standards		
Mandatory Emission Standards (Internal Combustion Engines)		
Heavy-Duty Emission Standards for New Vehicles and Engines (Mandatory)	ongoing	MSM
Heavy-Duty Omnibus Regulation (Mandatory Emission Standards)	2024	MSM
CARB's mandatory emission standards for heavy-duty vehicles and engines harmonize with federal standards for NOx and PM emission requirements though MY 2023. For MY 2024 and later, the Omnibus regulation established new low NOx and lower PM Standards that, when implemented, will be the lowest in the nation. Adopted in 2021, the omnibus regulation is a technology-forcing regulation; further stringency is infeasible. The Omnibus regulation also lengthened the useful life and emissions warranty provisions for heavy-duty diesel engines. Heavy-Duty emission standards for new vehicles and engines require years of lead time to be developed, certified, manufactured, and implemented; a more accelerated timeline is infeasible.		
Optional Emission Standards (Internal Combustion Engines)		
Optional Low-NOx Emission Standards for Heavy-Duty Engines	ongoing	MSM
Heavy-Duty Omnibus Regulation (Optional Emission Standards)	2024	MSM
CARB's optional Low-NOx emission standards are the most stringent in the nation, and are technology-forcing regulations that have driven the development and market readiness of the cleanest heavy-duty engines. The Omnibus regulation, when implemented, will further lower CARB's optional low-NOx emission standards to an even lower level; further increases in stringency are not feasible. Vehicle emission standards, including optional standards, are dependent on technological development, and require years of lead time to be developed, certified, manufactured, and implemented; a more accelerated timeline is infeasible.		
Zero-Emission Truck Standards – Sales and Manufacturer Requirements		
Advanced Clean Trucks	2024	MSM
Adopted in 2020, the Advanced Clean Trucks (ACT) regulation established manufacturer zero-emission truck sales requirements for Class 2b – Class 8 trucks beginning in 2024, as well as company and fleet reporting requirements. The ACT regulation has the most stringent zero-emission truck requirements in the nation. As a technology-forcing regulation, ACT will accelerate the development and deployment of Zero-Emission Heavy-Duty trucks and engines; further increases in stringency are not feasible. Manufacturer sales requirements need years of lead time to be implemented; it would be infeasible to implement on a more accelerated timeframe.		
Warranty, Useful Life, and On-Board Diagnostics (OBD) Requirements		
California Emission Control System Warranty and Maintenance Provisions	ongoing	MSM
Amendments to Useful Life & Warranty Provisions (as part of Omnibus)	2027	MSM
For MY 2022 - 2026 engines, California's Emission Control System Warranty and Maintenance Provisions are the most stringent in the nation. Adopted in 2021, the Omnibus Regulation further amended the warranty and useful life provisions for heavy-duty engines for MY 2027 and later years. To help ensure emission controls are well maintained and repaired when needed, and to help ensure more durable emission control systems, Omnibus extends the criteria pollutant emissions warranty and useful life period requirements for heavy-duty vehicles and engines. For My 2027 – 2031 and later years, California warranty and useful life requirements are at least as stringent as the federal requirements. As technology-forcing regulations, California's warranty and maintenance provisions are the most stringent in the nation; further increases in stringency are not feasible. Likewise, an accelerated timeline is not feasible; the requisite technological innovations and developments needed to meet California's level of stringency require years of lead time for implementation, as manufacturers must have sufficient time to develop, test, certify, and manufacture these needed advanced technologies.		
Heavy-Duty On-Board Diagnostics (HD OBD) and OBD II	ongoing	MSM
Amendments to Useful Life & Warranty Provisions (as part of Omnibus)	2024	MSM
The Heavy-Duty OBD regulation required that all MY 2013 and later engines offered for sale in California come equipped with OBD systems. CARB and federal OBD regulations for heavy-duty vehicles generally align for MY2013 – current engines, although CARB's program has been amended to be more stringent than U.S. EPA's for certain vehicle types. With the 2021 adoption of the Omnibus regulation, California's threshold for OBD requirements will become more stringent, concurrent with the phase-in of more stringent emission requirements. Omnibus also requires 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		

Measures	Implementation Begins	12 µg/m³ Annual PM2.5 Standard (2012)
manufacturers to develop, test, and manufacture the needed hardware and/or software changes, and to verify via testing; an accelerated timeline for implementation is therefore not feasible.		
In-Use Emission Control Measures		
Inspection and Maintenance Provisions		
HD Diesel Vehicle Inspection Program (HDVIP)	ongoing	MSM
Periodic Smoke Inspection Program (PSIP)	ongoing	MSM
HD Inspection and Maintenance Program (HD I/M)	ongoing	MSM
Heavy-Duty In-Use Testing Program (HDIUT) (Part of Omnibus Regulation)	2024	MSM
California's in-use testing program (including the HD I/M, HDVIP and PSIP regulations) is the most stringent in the nation, with further increases in stringency going into effect in 2024 (HDIUT). • Amended in 2018, HDVIP requires heavy duty vehicles to be inspected for smoke opacity, tampering, and engine certification label compliance. PSIP identifies malfunctioning PM emission control components and requires their repair. The 2018 amendments to HDVIP and PSIP lowered the smoke opacity limits and required engines over four years old to be inspected annually. • Adopted in 2021, HD I/M is a comprehensive heavy-duty vehicle inspection and maintenance regulation requiring periodic vehicle emissions testing and reporting on nearly all heavy-duty vehicles operating in California. Combining periodic vehicle testing with other emissions monitoring and expanded enforcement strategies, the HD I/M regulation ensures that vehicles' emissions control systems are properly functioning when traveling on California's roadways, and that polluting, poorly maintained heavy-duty vehicles operating in California are quickly identified and repaired. As of 2023, CARB is using roadside emissions monitoring devices (REMD) to screen for vehicles that may have high emissions. • To ensure that in-use heavy-duty vehicles continue to operate at their cleanest possible level, the 2020 Omnibus regulation amended the Heavy-Duty In-Use Testing (HDIUT) Program by revising procedures to better represent heavy-duty vehicle operations in real world conditions, establishing clearer criteria for engine family pass/fail determination, and requiring on-board diagnostic (OBD) data during testing to verify the condition of the test vehicle and sensors. California's HD inspection and maintenance requirements are the most stringent in the nation; further increases in stringency are not feasible. Further increases in stringency under the Omnibus Regulation take effect next year and are phased-in in subsequent years to allow regulated parties and manufacturers sufficient lead time to comply with the regulation's stringency; a more accelerated timeline is infeasible.		
Diesel Idling Requirements		
HD Idling Reduction Program	ongoing	MSM
Reduced Idling Limits (as part of Omnibus)	2024	MSM
School Bus Idling ATCM	ongoing	MSM
The HD Idling Reduction Program requires that drivers of diesel-fueled commercial motor vehicles (GVWR < 10,000 lbs), including buses and sleeper berth equipped trucks, not idle the vehicle's primary diesel engine longer than five minutes at any location. The regulation also consists of new engine and in-use truck requirements and emission performance requirements for technologies used as alternatives to idling the truck's main engine. Under the new engine requirements, 2008 and newer model year heavy-duty diesel engines need to be equipped with a non-programmable engine shutdown system that automatically shuts down the engine after five minutes of idling. The Omnibus regulation further reduces diesel idling limits from 30 g/hr to 10 g/hr in MY 2024, and to 5 g/hr in MY 2027+ engines. In addition to the idling limits required under the HD Idling Reduction program and the Reduced Idling Limits as part of the Omnibus Regulation, the School Bus Idling Airborne Toxic Control Measure (School Bus ATCM) further limits bus and commercial motor vehicle idling near schools or at school bus destinations to only when necessary for safety or operational concerns. California's idling requirements are the most stringent in the nation; further increases in stringency are not feasible. Reduced idling limits from the Omnibus Regulation take effect next year (2024+) and are phased-in in subsequent years to allow regulated parties and manufacturers sufficient lead time to comply with the regulation's stringency; a more accelerated timeline is infeasible.		
Fleet Rules - General		
Truck and Bus	ongoing	MSM

Measures	Implementation Begins	12 µg/m³ Annual PM2.5 Standard (2012)
Advanced Clean Fleets (ACF) Regulation (2022 State SIP Strategy measure, adopted April 2023)	2024	MSM
Zero-Emission Trucks Measure (2022 State SIP Strategy measure with commitment)	2030	MSM
California's heavy-duty fleet rules are the most stringent in the nation, and have continually relied on the newest developments in advanced clean technologies that are spurred by CARB's new engine and vehicle standards. For the timeline of analysis for this document, there have been / will be three generations of fleet rules, which transition California's heavy-duty fleet from low-emission internal combustion engines to increasingly stringent requirements for zero-emission technologies: • Adopted in 2010, the Truck and Bus regulation requires heavy-duty diesel vehicles that operate in California to reduce exhaust emissions. By 2023, nearly all trucks and buses will be required to have 2010 or newer model year engines to reduce PM and NOx. • Building on the successful emission reductions from Truck and Bus, the Advanced Clean Fleets (ACF) regulation would transition CARB's fleet rules toward establishing zero-emission purchasing requirements for medium- and heavy-duty vehicle fleets (including state and local agencies, and drayage fleets, high priority, and federal fleets), beginning in 2024. ACF would also require 100% zero-emission new vehicle sales starting 2040. Under the recently-adopted ACF regulation, together with the ACT regulation, the number of medium- and heavy-duty ZEVs operating in California will be about 1.2 7 million by 2045. • The future Zero-Emission Trucks Measure would build on the rollout of ZE trucks through the Advanced Clean Trucks and Advanced Clean Fleets regulations by going beyond ACF requirements and further increasing the number of ZEVs, with the goal of achieving a full ZEV fleet by 2045 everywhere feasible. It would seek to expand the ZEV market in a manner that is economically feasible for more than 100,000 fleets where some cannot afford to purchase new trucks and will not be able to operate without access to retail ZEV infrastructure, especially for long-haul and inter-state vehicles. Fleet requirements need years of lead time to be implemented for reasons of technological and economic feasibility. As purchasing requirements and fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements. California's currently committed to heavy-duty fleet requirements are technology-forcing and are the most stringent in the nation, as they will eventually exclusively require zero-emission trucks and engines; further increases in stringency are not feasible.		
Fleet Rules - Drayage Trucks		
Truck and Bus	ongoing	MSM
Advanced Clean Fleets (ACF) Regulation (2022 State SIP Strategy measure, adopted April 2023)	2024	MSM
Drayage trucks are subject to requirements under the Truck and Bus Regulation, which requires MY 2010 or newer engines on drayage trucks entering ports and rail yards, beginning in on January 1, 2023. Under the Advanced Clean Fleets (ACF) Regulation, CARB will further strengthen emission controls for drayage fleets with zero-emission drayage truck requirements. Drayage trucks will be required to start transitioning to zero-emission technology beginning in 2024, with full implementation by 2035. Fleet requirements need years of lead time to be implemented for reasons of technological and economic feasibility. As purchasing requirements and fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements. California's fleet requirements for drayage trucks are technology-forcing and are the most stringent in the nation, as they will require zero-emission trucks and engines; further increases in stringency are not feasible.		
Fleet Rules - Solid Waste Collection Vehicles (SWCVs)		
Solid Waste Collection Vehicle Regulation	ongoing	MSM
Truck and Bus	ongoing	MSM
Advanced Clean Fleets (ACF) Regulation (2022 State SIP Strategy measure, adopted April 2023)	2024	MSM
Adopted in 2003, the Solid Waste Collection Vehicle Regulations reduce diesel PM from SWCVs by requiring engines equivalent to the 2007 MY standard of 0.01 g/bhp-hr. SWCVs are also subject to requirements under the Truck and Bus Regulation, which requires MY 2010 or newer engines as of January 1, 2023. The ACF regulation will accelerate ZEV adoption among SWCVs, with a goal of 100 percent ZE vehicle sales in California starting in 2036. Fleet requirements need years of lead time to be implemented for reasons of technological and economic feasibility. As purchasing requirements and fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements. California's fleet requirements for SWCVs are technology-forcing and are the most stringent in the nation, as they will require zero-emission trucks and engines; further increases in stringency are not feasible.		
Fleet Rules - Public Agencies and Utilities		

Measures	Implementation Begins	12 µg/m³ Annual PM2.5 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
The Public Agency and Utility Regulation requires PM emission limits comparable to the 2007 MY standard of 0.01 g/bhp-hr for engine MY 1960 or newer. Some public and utility fleets are also subject to requirements of Truck and Bus, and must have MY 2010 or newer engines as of January 1, 2023. The ADF regulation accelerates ZEV adoption among all state and local government and utility fleets, starting with a 50% purchase requirement in 2024, with increasingly stringent requirements phased-in over subsequent years. Fleet requirements need years of lead time to be implemented for reasons of technological and economic feasibility. As purchasing requirements and fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements. California's fleet requirements for public and utility fleets are technology-forcing and are the most stringent in the nation, as they will require zero-emission trucks and engines; further increases in stringency are not feasible.		
Fleet Rules - Transit Agencies		
Fleet Rule for Transit Agencies	ongoing	MSM
Innovative Clean Transit	2023	MSM
The Transit Fleet Rule requires PM and NOx emission reductions from urban buses and transit fleet vehicles, and required future zero-emission bus purchases. Adopted in 2018, the Innovative Clean Transit (ICT) Regulation requires all public transit agencies to gradually transition to a 100 percent zero-emission bus (ZEB) fleet. Beginning in 2029, 100% of new purchases by transit agencies must be ZEBs, with a goal for full transition by 2040. Fleet requirements need years of lead time to be implemented for reasons of technological and economic feasibility. As purchasing requirements and fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements. California's fleet requirements for transit agencies are technology-forcing and are the most stringent in the nation, as they will require zero-emission trucks and engines; further increases in stringency are not feasible.		
Fleet Rules - Airport Shuttle Buses		
Truck and Bus	ongoing	MSM
Zero-Emission Airport Shuttle Buses	2027	MSM
The Truck and Bus Regulation requires airport shuttle buses to use MY 2010 or equivalent engines by 2023. The Zero-Emission Airport Shuttle Bus Regulation requires airport shuttle operators to transition to 100 percent zero-emission vehicle (ZEV) technologies. Airport shuttle operators must begin adding zero-emission shuttles to their fleets in 2027, and complete the transition to ZEVs by the end of 2035. Fleet requirements need years of lead time to be implemented for reasons of technological and economic feasibility. As purchasing requirements and fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements. California's fleet requirements for airport shuttle buses are technology-forcing and are the most stringent in the nation, as they will require zero-emission trucks and engines; further increases in stringency are not feasible.		
School Buses – In-Use Control Programs		
Truck and Bus	ongoing	MSM
School Bus Idling ATCM	ongoing	MSM
Heavy-Duty Omnibus Regulation	2024	MSM
School Bus Incentive Program	ongoing	MSM
The Truck and Bus regulation applies to school buses > 14,000 lbs., GVWR, and requires the use of diesel particulate filters. The School Bus Idling Airborne Toxic Control Measure (School Bus ATCM) further limits bus and commercial motor vehicle idling near schools or at school bus destinations to only when necessary for safety or operational concerns. Under the Omnibus Regulation, idling limits for diesel heavy-duty vehicles will be reduced from 30 g/hr currently to 10 g/hr in MY 2024 and to 5 g/hr in MY 2027. CARB also uses incentive funds as a key component of the strategy to reduce emissions from the school bus fleet. Over the past two decades, CARB's School Bus Incentive Program has invested over $1.2 billion to date to clean up old, higher-polluting school buses, which has supported about 1,800 zero emission school buses. California's requirements for in-use control programs for school buses are among the most stringent in the nation; it would be infeasible to accelerate the implementation schedule, or require further increases in stringency.		
Fuels Control Measures		
Conventional Diesel Fuel Standards		
CARB Ultra Low Sulfur Diesel (ULSD)	ongoing	MSM

Measures	Implementation Begins	12 µg/m³ Annual PM2.5 Standard (2012)
Low-Emission Diesel Requirement (2016 State SIP Strategy measure, not yet adopted)	TBD	MSM
CARB's Ultra Low Sulfur Diesel (ULSD) regulation was last amended 2003 to establish more stringent standards for diesel fuel, lowering the sulfur limit to 15 ppmw. Relative to federal diesel requirements, CARB ULSD reduces NOx and PM emissions significantly. The Low Emission Diesel measure will require diesel fuel providers to steadily decrease criteria pollutant emissions from their fuels, which will reduce NOx and PM tailpipe emissions. CARB fuel regulations reduce emissions from even those vehicles registered out of state and therefore not subject to CARB's other mobile source control measures. CARB's diesel standards and requirements are the most stringent in the nation, and some of the most stringent in the world; it is not feasible to require further stringency of fuel specifications.		
Alternative Fuel Standards		
Low Carbon Fuel Standard (LCFS)	ongoing	MSM
Alternative Diesel Fuel (ADF) Regulation	ongoing	MSM
The LCFS and ADF regulations work together to reduce the carbon intensity of the California fuel supply. The regulations also limit criteria emissions from alternative fuels and/or alternative fuel mix blends. The regulations were amended in 2018 to extend the carbon intensity target of 20 percent to 2030. No other state or federal requirements have set as stringent of criteria emission requirements on alternative fuels and alternative fuel blends than California. The LCFS and ADF are technology-forcing regulations, and are the most stringent in the nation; further stringency would not be feasible. As it takes fuel producers years to develop, certify, and manufacture new alternative fuel types to meet the increasingly stringent requirements of the LCFS and ADF, an accelerated implementation timeframe would not be feasible.		

STEP 3(B): EVALUATION OF FEASIBILITY: MEDIUM- AND HEAVY-DUTY CONTROL MEASURES

Step 3(b) calls for an assessment of the feasibility of implementing any measure that is not included in the 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.

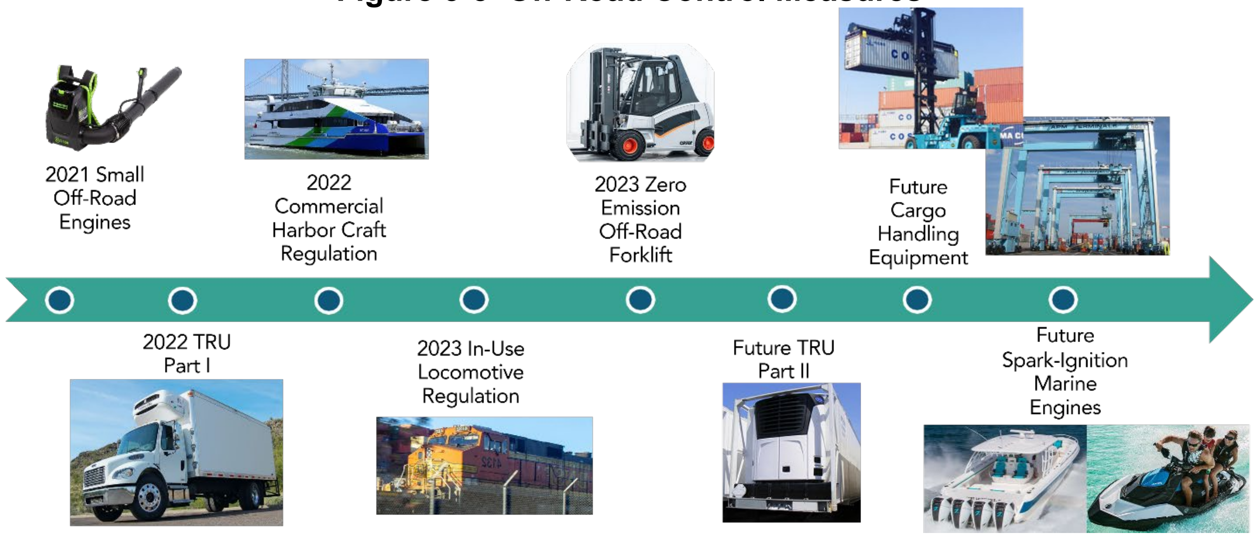
As the Valley is home to one of the most productive agricultural regions in the world, farm equipment is also an important off-road source category for the Valley. The farm equipment category is composed of agricultural equipment that includes tractors, agricultural tractor-trailers, harvesting equipment, 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 NOx 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 NOx, PM, and carbon (CO2) emissions (referred to as Tier 5) for all off-road engine power categories, including those that do not currently utilize exhaust aftertreatment such as diesel particulate filters (DPF) and selective catalytic reduction (SCR). CI engines are used in a wide range of off-road equipment including tractors, excavators, bulldozers, graders, and backhoes. As of model year 2020, more than half of all new off-road CI engine families continue to be certified to California's most stringent (Tier 4 final) emission standards without the need for DPFs. This means that most new off-road CI engines are not reducing toxic diesel PM to the greatest extent feasible using the best available technology. The proposed new Tier 5 standards and test procedures would be more stringent than required by current U.S. EPA and European Stage V nonroad regulations and would require the use of best available technologies for both PM and NOx. Lower NOx standards – up to 90 percent below the current Tier 4 final emission standard levels – coupled with lower PM standards, would force engine manufacturers to incorporate DPFs, which many currently do not have. DPFs would also ensure greater reductions in ultrafine PM, which may pose a health concern separate from PM emissions as a whole.

CARB has also engaged in a number of feasibility studies and technological demonstrations of the requisite technologies for this measure:

- CARB funded a research effort demonstrating the feasibility of advanced aftertreatment on 79 small off-road CI engines, which was completed by the Center for Environmental Research and Technology (CE-CERT) in 2019. Small off-road CI engines (less than 56-kilowatt [kW] or 75 hp) are not currently required to comply with advanced NOx aftertreatment-based standards, and a subset of these engines that are less than 19 kW (25 hp) are not required to comply with advanced PM aftertreatment--based standards. Small off-road CI engines account for between 20 to 40 percent of the off-road diesel PM and NOx emissions inventories in California.[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.

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

[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- operation[96] 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 PM2.5 and NOx as new farm equipment is introduced into the fleet.

In-Use Controls: Agricultural Equipment

New engines used in agricultural equipment, primarily tractors, must meet the same standards as other off-road engines ensuring that new equipment becomes progressively cleaner. Just as in other off-road applications, diesel agricultural equipment can remain in use for long periods of time. This long life means that equipment with new, lower emitting engines are introduced into the fleet at a relatively slower pace than what is needed to meet air quality standards. 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 NOx 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 NOx 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 lead 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+NOx, starting January 1, 2013. Non-mobile GSE such as portable air-start units, ground power units and air conditioners may be subject to the ***Portable Diesel-Engines Air Toxic Control Measure*** (ATCM). The ATCM reduces PM emissions by requiring engine replacement in a schedule based on a fleet's weighted PM emission average.

CARB is also anticipated to further increase the stringency of emission controls with the ***Zero-Emission Airport Ground Support Equipment measure***, a measure committed to in the 2016 State SIP Strategy, which will act as a catalyst to further adoption of zero-emission equipment in the off-road sector, facilitate the transfer of technology to suitable heavier duty-cycle applications, and expand use of zero-emission infrastructure.

Cargo Handling Equipment (CHE)

Emission Standards for Airport CHE

California's ***Cargo Handling Equipment Regulation*** set performance standards for engines in newly acquired, as well as in-use, mobile CHE at ports or intermodal rail yards in California. Mobile CHE is used to transfer goods or perform maintenance and repair activities and includes equipment such as yard trucks (hostlers), top handlers, side handlers, reach stackers, forklifts, rubber-tired gantry cranes, dozers, excavators, loaders, and railcar movers used in maintenance operations at ports and intermodal rail yards. CARB's CHE Regulation was originally adopted in 2005 to establish BACT requirements for new and in-use cargo handling equipment that operate at California's ports and intermodal rail yards, and was amended in 2011 to include opacity monitoring requirements. CARB obtained authorization for the 2005 version of the regulation in 2012. Under the CHE Regulation, all newly purchased yard truck and non-yard truck equipment brought onto a port or intermodal rail yard must have either a Tier 4 Final off-road engine or an on-road engine meeting the 2010 or newer on-road emission standards. CHE Regulations set performance standards for engines in newly acquired, as well as in-use, mobile CHE at ports or intermodal rail yards in California.

CARB staff anticipates increasing the stringency of emission standards for CHE with the ***Amendments to CHE Regulation***. In March 2018, CARB staff presented to the Board a plan to begin development of a regulation to transition CHE to zero-emission technologies, and to minimize emissions and community health impacts from cargo handling equipment. The CHE amendments would set in-use requirements for diesel cargo handling equipment at ports and rail yards, including but not limited to yard trucks (hostlers), rubber-tired gantry cranes, container handlers, and forklifts. The regulatory amendments would propose to start transitioning CHE to zero-emission with an implementation schedule for new equipment and facility infrastructure requirements, with effective dates beginning in 2026. Staff would assess the availability and performance of zero-emission technology as an alternative to all combustion-powered cargo equipment and evaluate additional solutions that may include efficiency improvements. Based on the current state of zero-emission CHE technological developments, the transition to zero-emission would most likely be achieved largely through the electrification of CHE. In this potential action, all mobile equipment at ports and rail yards, including but not limited to diesel, gasoline, natural gas, and propane-fueled equipment, would be subject to new requirements. Staff anticipates that all yard trucks and forklifts would be zero-emission by 2030, rubber-tired gantry cranes would be zero-emission by 2032, and 90 percent of other CHE will be zero-emission by 2036. These assumptions are supported by the fact that currently some electric rubber tire gantry cranes, electric forklifts, and electric yard tractors are already commercially available. Other technologies are in early production or demonstration phases. CARB staff would also consider opportunities to prioritize the earliest implementation in or adjacent to the communities most impacted by air pollution. Board consideration for adoption of these amendments is anticipated in 2024.

In-Use Controls: CHE

As described earlier, the ***Cargo Handling Equipment Regulation*** (adopted in 2005, amended in 2011) includes performance standards for in-use, mobile CHE at ports or intermodal rail yards in California. CARB's CHE Regulation was originally adopted in 2005 to establish BACT requirements for new and in-use cargo handling equipment that operate at California's ports and intermodal rail yards, and was amended in 2011 to include opacity monitoring requirements. CARB obtained authorization for the 2005 version of the regulation in 2012. Under the CHE Regulation, all legacy in-use non-yard truck engines that are still in service (Tier 0 – Tier 3) must have a Verified Diesel Emission Control Strategy (VDECS) installed.

CARB anticipates increasing the stringency of in-use requirements with the CHE measure committed to in the 2022 State SIP Strategy. CARB's proposed ***Amendments to the Cargo Handling Equipment Regulation*** would set in-use requirements for diesel cargo handling equipment at ports and rail yards, including but not limited to yard trucks (hostlers), rubber-tired gantry cranes, container handlers, and forklifts. Staff would assess the availability and performance of zero-emission technology as an alternative to all combustion-powered cargo equipment and evaluate additional solutions that may include efficiency improvements. The regulatory amendments would propose an implementation schedule for new equipment and facility infrastructure requirements, with effective dates beginning in 2026.

Commercial Harbor Craft (CHC)

Emission Standards and in-use controls for CHC

The ***Commercial Harbor Craft Regulation*** reduces diesel PM and NOx emissions from a number of types of CHC operating in California. CARB's 2008 and 2011 CHC

Regulations required NOx and diesel PM emission controls on crew and supply boats, ferries, excursion vessels, towboats, push boats, tug boats, barges, and dredges.

CARB adopted the ***Amended CHC Regulation in 2022***, establishing expanded and more stringent in-use requirements to cover more vessel categories, including all tank barges, pilot vessels, research vessels, workboats, commercial passenger fishing, and commercial fishing vessels. The amendments also mandate accelerated deployment of zero-emission and advanced technologies in vessel categories where technological feasibility has been demonstrated. Starting in 2023 and phasing in through 2031, most CHC (except for commercial fishing vessels and categories listed below) are required to meet the cleanest possible standard (Tier 3 or 4) and retrofit with DPF based on a compliance schedule. The current regulated CHC categories are ferries, excursion, crew and supply, tug/tow boats, barges, and dredges. The amendments impose in-use requirements on the rest of vessel categories except for commercial fishing vessels, including workboats, pilot vessels, commercial passenger fishing, and all barges over 400 feet in length or otherwise meeting the definition of an ocean-going vessel. The amendments also remove the current exemption for engines less than 50 horsepower. Starting in 2025, all new excursion vessels are required to be plug-in hybrid vessels that are capable of deriving 30 percent or more of combined propulsion and auxiliary power from a zero-emission tailpipe emission source. Starting in 2026, all new and in-use short run ferries are required to be zero-emission; and starting in 2030 and 2032, all commercial fishing vessels need to meet a Tier 2 standard at minimum. The 2022 Amendments to the Commercial Harbor Craft (CHC) Regulation also require the use of at least 99 percent Renewable Diesel (“R100” or “R99”). The use of renewable diesel in CHC will achieve additional emission reductions to the already reduced emissions from Tier 3 or Tier 4 engines plus diesel particulate filters (DPF). Renewable diesel has been required to be used by all CHC operating in the State as of January 1, 2023.

Forklifts

Emission Standards for Forklifts

Forklifts operate in many different industry sectors but are most prevalent in manufacturing and at locations such as warehouses, distribution centers, and ports. Diesel-fueled forklifts were first subject to engine standards and durability requirements in 1996. The most recent ***Tier 4 Final emission standards*** were phased in starting in 2013. Tier 4 emission standards are based on the use of advanced after-treatment technologies such as diesel particulate filters and selective catalytic reduction. Forklifts powered by LSI engines (gasoline and natural gas) have been subject to new engine standards that include both criteria pollutant and durability requirements since 2001, with the cleanest requirements phased-in starting in 2010.

CARB staff anticipates further increases to the stringency of emission controls with the ***Zero-Emission Off-Road Forklift Regulation Phase I measure***, a commitment from the 2016 State SIP Strategy, which would accelerate the deployment of zero-emission forklift technologies. The regulatory amendments would propose requirements that prohibit the new purchases of LSI forklifts, with an implementation schedule beginning in 2026. Forklifts are also subject to further controls under the ***Off-Road Zero-Emission Targeted Manufacturer Rule measure***, which CARB committed to in the 2022 State SIP Strategy. This measure would accelerate the deployment of zero-emission forklifts through a measure requiring manufacturers to produce zero-emission equipment and/or powertrains as a percentage of their sales volume.

In-Use Controls: Forklifts

Forklift fleets are subject to both the ***LSI Fleet Regulation*** (if powered by gasoline or propane), and the ***Off-Road Diesel Fleet Regulation*** (if powered by diesel) are required to retire, repower, or replace higher-emitting equipment in order to maintain fleet average standards. The ***Off-Road Diesel Regulation*** was adopted by the Board in 2007 with implementation beginning in 2010. It is applicable to all diesel-fueled, self-propelled off-road equipment with at least 25 HP. Forklifts are included in the fleet average along with other equipment. Additionally, the ***LSI fleet Regulation*** (which was originally adopted with requirements beginning in 2009) requires fleets with four or more LSI forklifts to meet fleet average emission standards. While the LSI fleet Regulation applies to forklifts, tow tractors, sweeper/scrubbers, and airport ground support equipment, it maintains a separate fleet average requirement specifically for forklifts.

With the recent adoption of the ***2022 Amendments to the In-Use Off-Road Diesel-Fueled Fleets Regulation,*** forklifts are also subject to begin transitioning to zero-emission technologies. Beginning in 2024, requirements begin to transition fleets from the oldest and highest-emitting off-road engines in operation in California by phasing out Tier 0 – Tier 2 equipment. Also beginning in 2024, the regulation includes requirements to restrict the addition of new vehicles and/or engines with Tier 3 and 4i engines, which is an expansion of the provisions of the current regulation, which restrict the vehicle-engine tiers that can be added to a fleet. The regulation also includes elements that require contracting entities to obtain and retain a fleet's valid Certificate of Reported Compliance prior to awarding a contract or hiring a fleet, mandate the use of R99 or R100 Renewable Diesel for all fleets, with some limited exceptions; provide voluntary compliance flexibility options for fleets that adopt zero-emission technology; and include additional requirements to increase enforceability, provide clarity, and provide additional flexibility for permanent low-use vehicles.

CARB is anticipated to further increase the stringency of in-use emission controls for forklifts with the ***Zero-Emission Off-Road Forklift Regulation Phase I measure,*** a measure committed to in the 2016 State SIP Strategy, which would be designed to accelerate the deployment of zero-emission forklift technologies. The regulatory amendments would propose requirements for fleets to retire existing LSI forklifts that are 13 years and older, and would propose an implementation schedule beginning in 2026. Under the ***Amendments to the Cargo Handling Equipment Regulation measure***, which CARB committed to in the 2022 State SIP Strategy, forklifts operating at ports and intermodal rail yards would also be subject to begin transitioning to zero-emission technologies. Staff anticipates that all forklifts operating at ports and intermodal rail yards would be zero-emission by 2030, which is supported by the fact that currently some electric forklifts are already commercially available, with other technologies are in early production or demonstration phases.

Marine Engines

Emission Standards for Marine Engines

U.S. EPA first promulgated exhaust emission standards to reduce emissions of HC and NOx from new outboard and personal watercraft engines in 1996, which were to begin in 2006. In 1998, CARB adopted the ***Exhaust Emission Regulations for Spark-Ignition Marine Engines***, which accelerated the federal standard's 2006 implementation date to 2001 in California, and also set more stringent California standards for outboard and personal watercraft engines that took effect in 2004 and 2008. In 2001, CARB amended the ***Spark-Ignition (SI) Marine Regulations*** to include HC+NOx emission standards for new sterndrive and inboard marine engines. These standards adopted Tier I and ***Tier II emission standards for inboard and stern-drive marine engines***. In 2007, U.S. EPA harmonized with CARB's accelerated implementation schedule and more stringent exhaust standards for outboard and personal watercraft engines, and also granted California authorization to enforce CARB's regulations for Outboard Engines and Personal Watercraft engines and Tier I of the California inboard and stern-drive marine engine emissions standards. In 2011, U.S. EPA granted California authorization to enforce CARB's Tier II exhaust emission standards for spark ignited inboard and stern-drive marine engines. The Tier II Emission Standards for Inboard and Stern-Drive Marine Engines (2001) controls emissions at the same level of stringency as national regulations. While CARB has the same exhaust emission standards as the federal standard, the California standard applies to engines sooner, starting in 2008 rather than 2010 under the federal requirement.
In February 2015, CARB Board approved more stringent ***Evaporative Emission Control Standards*** than those set forth by the U.S. EPA's 2008 rule for gasoline-fueled spark-ignition marine watercraft configured with engines greater than 30 kilowatts. The Evaporative Emission Control Standards (2015) exceeds the stringency of applicable national regulations set by U.S. EPA in 2008 for gasoline-fueled spark-ignition marine watercraft >30 kilowatts.

CARB anticipates proposing further increases in stringency for Spark-Ignition Marine Engine Standards. The ***Spark-Ignition Marine Engine Standards measure*** from the 2022 State SIP Strategy would reduce emissions from new spark-ignition (SI) marine engines by adopting more stringent exhaust standards for outboard and personal watercraft, which currently do not use catalyst control technologies. Staff estimates that stricter standards could reduce combined HC or ROG and NOx emissions by approximately 70 percent below the current HC+NOx standard (≈16.5 grams per kilowatt-hour (g/kW-hr)) for engines greater than or equal to 40 kilowatts (kW) in power, and by approximately 40 percent for engines less than 40 kW in power. CARB staff is also evaluating whether some outboard and personal watercraft vessels could be propelled by zero-emission technologies in certain applications. For example, zero-emission powertrains have the potential to gradually replace most outboard engines less than 19 kW, as well as many new personal watercraft engines.

Off-Highway Recreational Vehicles (OHRV)

Emission Standards for OHRV

Off-road recreation vehicles, also known as off-highway recreational vehicles (OHRV), primarily include off-highway motorcycles, all-terrain vehicles (ATVs), and utility-terrain vehicles, off-road sport and utility vehicles, sand cars, and golf carts. In 1994, CARB adopted its first OHRV regulation, which established ***exhaust emission standards for OHRVs***. At that time, there were no equivalent federal standards regulating exhaust emissions from the vehicles and engines covered by California's OHRV regulations (U.S. EPA first set exhaust emission limits for OHRVs in 2002). U.S. EPA granted authorization for CARB's 1994 OHRV regulations in 1996. CARB subsequently amended the regulations to increase the stringency of controls and expand the categories of OHRVs controlled under the program; first in 1999, subsequently in 2003, and again in 2006. All three OHRV Engine Emission Standard amendments were granted authorization concurrently by U.S. EPA in 2014.[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/m^2/day) of total organic gas (TOG) for a 3-day diurnal period, and a fuel hose permeation limit of 15 g/m^2/day. At the time, these limits were identical to the national limits set by U.S. EPA. In July 2013, CARB adopted more stringent evaporative emission control standards for OHRVs that established a new test procedure and reduced evaporative emission limits to 1.0 g/m^2/day. Authorization was granted by U.S. EPA in 2017.[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 sunsetting the Red Sticker Program, including:

- Ending red sticker certification of new OHRV with no emissions controls beginning in model year 2022;
- Establishing transitional standards from 2020 through 2026; and
- Lifting the seasonal riding restrictions on existing red sticker vehicles starting on January 1, 2025.

Currently, this program is being phased-out to allow for more stringent emission control measures. In the meantime, however, the red-sticker program continues to control emissions from the in-use OHRV fleet.

Small Off-Road Equipment (SORE)

Emission Standards for SORE

Small Off-Road Engines (SORE) are spark-ignited engines rated at or below 19 kilowatts. This category includes handheld and non-handheld lawn and garden and industrial equipment such as string trimmers, leaf blowers, walk-behind lawn mowers, generators, and lawn tractors. They are used in applications such as lawn and garden, industrial, construction and mining, logging, airport ground support, commercial utility, and farm equipment, golf carts, and specialty vehicles. Staff estimates that there are approximately 16.5 million pieces of SORE equipment in California, the majority of which are spark-ignition (SI) engines used in residential and commercial lawn and garden applications, together with other utility and small industrial applications.

CARB first adopted ***SORE Exhaust Emission Standards and Test Procedures*** in 1990, with amendments in 1998 that increased the stringency and extended the types of engines and equipment applicable to the standard. In September 2003, CARB adopted more stringent exhaust emission standards, and set the first ***Evaporative Emission Standards*** for SORE. Prior to the adoption of these standards, evaporative emissions were uncontrolled. U.S. EPA granted full authorization for this suite of regulations in 2006, and these more stringent standards were phased-in for model years 2006 through 2013.[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/finalreg.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 (BSNF) are the two Class I, or major, freight railroads operating in California. There are also seven intrastate passenger commuter operators and up to 26 freight shortline railroads currently operating in California. UP and BNSF, however, generate

[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), NOx, 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 PM2.5.

U.S. EPA has previously promulgated two sets of national locomotive emission regulations (1998 and 2008). In 1998, U.S. EPA approved national regulations that primarily emphasized NOx reductions through Tier 0, 1, and 2 emission standards. Tier 2 NOx emission standards reduced older uncontrolled locomotive NOx emissions by up to 60 percent, from 13.2 to 5.5 g/bhp-hr.

In 2008, U.S. EPA approved a second set of national locomotive regulations. Older locomotives, upon remanufacture, are required to meet more stringent 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 NOx and PM emission standards*** (2015 and later model years). U.S. EPA Tier 4 NOx and PM emission standards further reduced emissions by approximately 90 percent from uncontrolled levels.

Beyond the currently adopted levels of controls, CARB staff petitioned U.S. EPA in 2017[108] 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/cleen

measure, CARB would explore requiring all larger airports to perform a comprehensive and standardized emission inventory. An accurate emission inventory that reflects all on-ground and near-ground emissions would establish a baseline and enable verifiable and quantifiable future emissions reductions. CARB would continue to assess technology development for the aviation sector. The purpose is to help inform and support CARB planning, regulatory, and voluntary incentive efforts. Concurrently, CARB would support, track, and explore current, in-development, and future emission reduction technology advancements. CARB would further evaluate federal, State, and local authority in setting operational efficiency practices to achieve emissions reductions. Operational practices include landing, takeoff, taxi, and running the APU, and contribute to on-ground and near-ground emissions. CARB would similarly work with U.S. EPA, air districts, airports, and industry stakeholders in a collaborative effort to develop regulations, voluntary measures, and incentive programs.

FUELS

In addition to new engines and in-use standards, cleaner burning fuels represent an important component in reducing emissions from the off-road mobile fleet. Cleaner fuel has an immediate impact in reducing emissions from the mobile source, and thus represent an important component in reducing NOx and PM emissions from off-road engines. California's stringent air quality programs treat mobile sources and their fuels holistically (as a system, rather than as separate components). As a result, CARB's fuels programs achieve significant reductions in criteria emissions from vehicles and mobile engines used in California.

CARB Diesel Fuel Regulations

The California diesel fuel program sets stringent standards for diesel fuel sold in California and produces cost-effective emission reductions from diesel-powered 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			
New Engine Standards: Off-Road Diesel Engine Emission Standards (general)	Tier 4 Off-Road Engine Standards (CARB and U.S. EPA) Future Measure: *Tier 5 Off-Road Vehicles and Equipment measure (CARB)*	California's emission standards for off-road diesel engines are consistent with those of U.S. EPA and the most stringent in the nation. CARB's current emission standards for new off-road engines with a power rating between 175 and 300 hp are set at the same level of stringency as federal standards, and requires Tier 4 emission standards (which use advanced after treatment technologies such as diesel particulate filters and selective catalytic reduction). This regulation is applicable to all diesel-fueled, self-propelled off-road equipment with at least 25 HP. With the Tier 5 Off-Road Vehicles and Equipment Measure, CARB has committed to develop and propose standards and test procedures for new off-road CI engines More stringent PM and NOx standards for engines greater than or equal to 56 kW (75 hp), including the following: • Aftertreatment-based PM standards for engines less than 19 kW (25 hp), • Aftertreatment-based NOx standards for engines greater than or equal to 19 kW (25 hp) and less than 56 kW (75 hp), and • First-time CO2 tailpipe standards targeting a 5 to 8.6 percent reduction. • Other possible elements include enhancing in-use compliance, proposing more representative useful life periods, idle requirements and developing a low load test cycle. It is expected that Tier 5 requirements would rely heavily on technologies manufacturers are developing to meet the recently approved low-NOx standards and enhanced in-use requirements for on-road- heavy-duty engines. *(Note: CARB has committed to pursue the Tier 5 Off-Road Vehicles and Equipment measure, but this measure has not yet been proposed to the Board for approval/adoption)*	No other state has more stringent exhaust emission standards for off-road equipment than California. Currently CARB and U.S. EPA limit exhaust emissions to same "Tier 4" levels: • NOx: 0.3 g/bhp-hr • PM: 0.015 g/bhp-hr
New Engine Standards: Off-Road Zero-Emission Engine Standards (general)	Future Measure: *Off-Road Zero-Emission Targeted Manufacturer Rule measure (CARB)*	The Off-Road Zero-Emission Targeted Manufacturer Rule would accelerate the development and production of zero-emission off-road equipment and powertrains into more sectors (including wheel loaders, excavators, and bulldozers) as technology advancements occur due to existing CARB zero-emission regulations and regulations in the forklifts, cargo handling equipment, off-road fleets, and small off-road engines sectors. For this measure, CARB would propose to develop a regulatory measure that would require manufacturers of off-road equipment and/or engines to produce for sale zero-emission equipment and/or powertrains as a percentage of their annual statewide	No other state requires zero-emission off-road engine standards.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
		sales volume to ensure these globally emerging zero-emissions products and related innovations come to California. *(Note: CARB has committed to pursue the Off-Road Zero-Emission Targeted Manufacturer Rule measure, but this measure has not yet been proposed to the Board for approval/adoption)*	
In-Use Emission Controls			
In-Use Emissions Controls: Fleet Rules (Off-Road Equipment – General)	In-Use Off-Road Diesel-Fueled Fleets Regulation (Off-Road Regulation) (CARB) Future Measure: *Clean Off-Road Fleet Recognition Program (CARB)*	California's in-use emission controls for off-road equipment are the most stringent in the nation. CARB's off-road regulation controls diesel PM and NOx emissions from >150,000 in-use off-road engines by requiring their owners to retire, replace, or repower older engines, and/or installing verified exhaust retrofit control technologies. Additionally, all vehicles are reported and labeled, and older, dirtier vehicles are restricted from entering fleets. With the 2022 Amendments to the In-Use Off-Road Diesel-Fueled Fleets Regulation, CARB further reduced emissions from the in-use off-road diesel equipment sector by increasing the stringency of the regulation's requirements. These amendments create additional requirements to the currently regulated fleets by targeting the oldest and dirtiest equipment that is allowed to operate indefinitely under the current regulation's structure. The amendments will require fleets to phase-out use of the oldest and highest polluting off-road diesel vehicles in California; prohibit the addition of high-emitting vehicles to a fleet; and require the use of R99 or R100 renewable diesel in off-road diesel vehicles. The amendments phase-in starting in 2024 through the end of 2036 and include changes to enhance enforceability and encourage the adoption of zero-emission technologies. CARB anticipates further emission reductions from the off-road equipment fleets through the Clean Off-Road Fleet Recognition Program measure, which would create a non-monetary incentive to encourage off-road fleets to go above and beyond existing regulatory fleet rule compliance and adopt advanced technology equipment with a strong emphasis on zero-emission technology. This measure would provide a standardized methodology for contracting entities, policymakers, state and local government, and other interested parties to establish guidelines for contracting criteria or require participation in the program to achieve their individual policy goals. *(Note: CARB has committed to develop the Clean Off-Road Fleet Recognition Program measure, but this measure has not yet been proposed to the Board for approval/adoption)*	While Chicago (IL) and New York City (NY) have in-use fleet controls for construction equipment, no other state or nonattainment area controls in-use off-road equipment fleets more stringently than CARB.
Source-Specific Rules			
New Engine Standards: Agricultural equipment	Tier 4 Off-Road Engine Standards (CARB and U.S. EPA)	U.S. EPA and California adopted equivalent Tier 4 standards in 2004 that require additional emission reductions from off-road engines, including those used in mobile agricultural equipment.	No state has more stringent requirements for new emission performance standards for agricultural equipment engines than California.
In-Use Emissions Controls: Agricultural Equipment	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 State SIP Strategy* 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			
	Future Measure: *Cleaner In-Use Agricultural Equipment measure (CARB)*	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 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. *(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.)*	
New Engine Standards: Airport Ground Support Equipment (GSE)	Large Spark Ignition (LSI) Fleet Regulation (CARB) Tier 4 Off-Road Engine Standards (CARB and U.S. EPA) Future measure: *Zero-Emission Airport Ground Support Equipment measure (CARB)*	California's emission controls for Airport Ground Support Equipment (GSE) are the most stringent in the nation. NOx limits for the LSI Engine Standard for engines > 1.0 liter (the typical engine size for GSE) is 0.6 g/bhp-hr. Engines meeting this standard are 70 percent cleaner than LSI engines produced as recent as 2009. Additionally, diesel engines in newly manufactured GSE must meet the Tier 4 emission standards applicable to off-road compression ignition engines. CARB is anticipated to further increase the stringency of emission controls with the Zero-Emission Airport Ground Support Equipment measure, which will act as a catalyst to further adoption of zero-emission equipment in the off-road sector, facilitate the transfer of technology to suitable heavier duty-cycle applications, and expand use of zero-emission infrastructure. *(NOTE: CARB has committed to pursue the Zero-Emission Airport Ground Support Equipment measure, but it has not yet been proposed to the Board for approval/adoption.)*	No other state has more stringent exhaust emission standards for airport ground support equipment than California.
In-Use Emissions Controls: Fleet Rules (Airport Ground Support Equipment)	In-Use Off Road Diesel-Fueled Fleets Regulation (CARB) Large Spark-Ignition (LSI) Engine Fleet Requirements Regulation (CARB) Portable Diesel-Engines Air Toxic Control Measure (CARB) Future Measure: *Zero-Emission Airport Ground Support Equipment measure (CARB)*	California's in-use emission controls for airport ground support equipment (GSE) are the most stringent in the nation. The In-Use Off-Road Diesel-Fueled Fleets Regulation requires GSE fleets operating in-use diesel equipment to meet an annual fleet average emissions target that decreases over time. For example, for equipment over 175 and under 750 HP, the final 2023 NOx fleet average target is 1.5 g/bhp hr, which is equivalent to the interim Tier 4 NOx standard for newly produced engines. Fleets that do not meet the required annual fleet average must meet the BACT requirements that require turnover, repower or retrofit of a specific percent of a fleet's total HP. These requirements are currently being phased in. Airport GSE fleets operating LSI GSE must meet the in-use LSI engine fleet requirements. Adopted in 2006, the LSI Engine Fleet Requirements Regulation requires GSE fleets to maintain an average emission level of no more than 2.5 g/bhp hr HC+NOx, starting January 1, 2013. Non-mobile GSE such as portable air-start units, ground power units and air conditioners may be subject to the Portable Diesel-Engines Air Toxic Control Measure (ATCM).	No other state or nonattainment area controls airport GSE more stringently than CARB.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
		CARB is anticipated to further increase the stringency of emission controls with the Zero-Emission Airport Ground Support Equipment measure. *(NOTE: CARB has committed to develop the Zero-Emission Airport Ground Support Equipment measure, but it has not yet been proposed to the Board for approval/adoption.)*	
New Engine Standards: Cargo Handling Equipment (CHE)	Cargo Handling Equipment Regulation (CARB) Future Measure: *Cargo Handling Equipment Amendments measure (CARB)*	California's emission controls for Cargo Handling Equipment (CHE) are the most stringent in the nation. CARB's Cargo Handling Equipment regulation sets performance standards for newly acquired engines, as well as in-use mobile CHE at ports or intermodal rail yards. CARB is anticipated to further increase the stringency of the CHE Regulation by transitioning CHE to zero-emission beginning in 2026. Based on the current state of zero-emission CHE technological developments, the transition to zero-emission would most likely be achieved largely through the electrification of CHE. Staff anticipates that all yard trucks and forklifts would be zero-emission by 2030, rubber-tired gantry cranes would be zero-emission by 2032, and 90 percent of other CHE will be zero-emission by 2036. *(Note: CARB has committed to pursue the Cargo Handling Equipment Amendments measure, but this measure has not yet been proposed to the Board for approval/adoption)*	No other state has more stringent exhaust emission standards for cargo handling equipment than California.
In-Use Emissions Controls: Fleet Rules (Cargo Handling Equipment)	Cargo Handling Equipment Regulation (CARB) Future measure: *Amendments to the Cargo Handling Equipment measure (CARB)*	California's in-use emission controls for cargo handling equipment (CHE) are the most stringent in the nation. The Cargo Handling Equipment regulation was adopted in 2005 to establish BACT requirements for in-use and newly purchased CHE, and amended in 2011 to include opacity monitoring requirements. The CHE regulation includes performance standards for in-use, mobile CHE at ports or intermodal rail yards in California, and requires that all newly purchased yard truck and non-yard truck equipment brought onto a port or intermodal rail yard must have either a Tier 4 Final off road engine or an on-road engine meeting the 2010 or newer on-road emission standards, and that all legacy in-use non-yard truck engines that are still in service (Tier 0 – Tier 3) must have a Verified Diesel Emission Control Strategy (VDECS) installed. CARB is anticipated to further increase the stringency with the Amendments to the Cargo Handling Equipment Regulation would set in-use requirements for diesel cargo handling equipment at ports and rail yards, including but not limited to: yard trucks (hostlers), rubber-tired gantry cranes, container handlers, and forklifts. Staff would assess the availability and performance of zero-emission technology as an alternative to all combustion-powered cargo equipment. The regulatory amendments would propose an implementation schedule for new equipment with effective dates beginning in 2026. *(Note: CARB has committed to pursue the Amendments to the Cargo Handling Equipment measure, but this measure has not yet been proposed to the Board for approval/adoption)*	No other state or nonattainment area has more stringent in-use fleet requirements for CHE than California.
New Engine Standards: Commercial Harbor Craft (CHC)	Commercial Harbor Craft Regulation (CARB)	California's emission controls for commercial harbor craft (CHC) are the most stringent in the nation. CARB's 2008 and 2011 CHC Regulations reduced NOx and diesel PM emissions from crew and supply boats, ferries, excursion vessels, towboats, push boats, tug boats, barges and dredges. CARB amended the CHC regulation in 2022, establishing expanded and more stringent in-use requirements to cover more vessel categories, including all tank barges, pilot	No other state has more stringent exhaust emission standards for commercial harbor craft than California.

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)	California's in-use emission controls for commercial harbor craft (CHC) are the most stringent in the nation. The Commercial Harbor Craft regulation (adopted in 2008 and amended in 2010) included in-use limits that required diesel PM and NOx emission controls on ferries, excursion vessels, and tugboats, towboats, and push boats. The 2011 amendments extended the types of CHC for which in-use engine requirements apply to include crew and supply, barges and dredges. CARB amended the CHC regulation in 2022, establishing expanded and more stringent in-use requirements to cover more vessel categories including all tank barges, pilot vessels, research vessels, workboats, commercial passenger fishing, and commercial fishing vessels. The amendments also mandate accelerated deployment of zero-emission and advanced technologies in vessel categories where technology feasibility has been demonstrated.	No other state or nonattainment area controls in-use CHC emissions more stringently than CARB.
New Engine Standards: Forklifts	Tier 4 Off-Road Engine Standards (CARB and U.S. EPA) Future Measures: *Zero-Emission Off-Road Forklift Regulation Phase 1 measure (CARB)* *Off-Road Zero-Emission Targeted Manufacturer Rule measure (CARB)*	California's emission controls for forklifts are the most stringent in the nation. Forklifts powered by LSI engines (gasoline and natural gas) are subject to new engine standards that include both criteria pollutant and durability requirements since 2001, with the cleanest requirements phased-in starting in 2010. Diesel Forklifts > 25 HP are subject to Tier 4 Final emission standards (based on the use of advanced after-treatment technologies such as diesel particulate filters and selective catalytic reduction) starting in 2013. CARB is anticipated to further increase the stringency of emission controls with the Zero-Emission Off-Road Forklift Regulation Phase I measure, which would be designed to accelerate the deployment of zero-emission forklift technologies. The regulatory amendments would propose requirements that prohibit the new purchases of LSI forklifts, with an implementation schedule beginning in 2026. *(NOTE: CARB has committed to pursue the Zero-Emission Off-Road Forklift Regulation Phase 1 measure, but it has not yet been proposed to the Board for approval/adoption.)* CARB is anticipated to further increase the stringency of in-use emission controls for forklifts through the Off-Road Zero-Emission Targeted Manufacturer Rule measure. *(NOTE: CARB has committed to pursue the Off-Road Zero-Emission Targeted Manufacturer Rule measure, but it has not yet been proposed to the Board for approval/adoption.)*	No state has more stringent requirements for new emission performance standards for forklifts engines than California.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
In-Use Emissions Controls: Fleet Rules (Forklifts)	Off-road Diesel Regulation (CARB) LSI Fleet Regulation (CARB) 2022 Amendments to the In-Use Off-Road Diesel Fueled Fleets Regulation (CARB) Future Measure: *Zero-Emission Off-Road Forklift Regulation Phase 1 (CARB)* Future Measure: *Amendments to the Cargo Handling Equipment measure (CARB)*	California's in-use emission controls for forklifts are the most stringent in the nation. Forklift fleets subject to both the LSI fleet regulation (if powered by gasoline or propane), and the off-road diesel fleet regulation (if powered by diesel) are required to retire, repower, or replace higher-emitting equipment in order to maintain fleet average standards. Diesel Forklifts > 25 HP are subject to fleet average emission requirements under the Off-Road Diesel Regulation starting in 2010. Under the 2022 Amendments to the In-Use Off-Road Diesel Fueled Fleets Regulation, forklifts are also subject to requirements begin to transition fleets from the oldest and highest-emitting off-road engines in operation in California by phasing out Tier 0 – Tier 2 equipment beginning in 2024. Also beginning in 2024, the regulation includes requirements to restrict the addition of new vehicles and/or engines with Tier 3 and 4i engines. CARB is anticipated to further increase the stringency of in-use emission controls with the Zero-Emission Off-Road Forklift Regulation Phase I measure, which would be designed to accelerate the deployment of zero-emission forklift technologies. The regulatory amendments would propose requirements for fleets to retire existing LSI forklifts that are 13 years and older, and would propose an implementation schedule beginning in 2026. *(NOTE: CARB has committed to develop the Zero-Emission Off-Road Forklift Regulation Phase 1 measure, but it has not yet been proposed to the Board for approval/adoption.)* CARB is also anticipated to further reduce the emissions from forklifts operating at ports and intermodal rail yards through the Amendments to the Cargo Handling Equipment Regulation measure. Under the CHE measure, forklifts would begin transitioning to zero-emission technologies. Staff anticipates that all forklifts operating at ports and intermodal rail yards would be zero-emission by 2030. *(NOTE: CARB committed to pursue the Amendments to the Cargo Handling Equipment measure, but this measure has yet to be proposed to the Board for approval/adoption.)*	No other state or nonattainment area has more stringent fleet requirements for in-use forklifts than CARB.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
New Engine Standards: Marine Engines	Exhaust Emission Regulations for Spark-Ignition Marine Engines (CARB) Tier II Emission Standards for Inboard and Stern-Drive Marine Engines (CARB) Evaporative Emission Control Standards (CARB) Future Measure: *Spark-Ignition Marine Engine Standards measure (CARB)*	CARB's recreational boats and marine engine program exceeds the stringency of U.S. EPA's federal standards and are the most stringent in the nation: • The Exhaust Emission Regulations for Spark-Ignition Marine Engines (1998) controls emissions at the same level of stringency as national regulations; • The Tier II Emission Standards for Inboard and Stern-Drive Marine Engines (2001) controls emissions at the same level of stringency as national regulations; and • The Evaporative Emission Control Standards (2015) exceeds the stringency of applicable national regulations set by U.S. EPA in 2008 for gasoline-fueled spark-ignition marine watercraft >30 kilowatts. The Spark-Ignition Marine Engine Standards measure would reduce emissions from new spark-ignition (SI) marine engines by adopting more stringent exhaust standards for outboard and personal watercraft, which currently do not use catalyst control technologies. Staff estimates that stricter standards could reduce combined HC or ROG and NOx emissions by approximately 70 percent below the current HC+NOx standard (≈16.5 grams per kilowatt-hour (g/kW-hr)) for engines greater than or equal to 40 kilowatts (kW) in power, and by approximately 40 percent for engines less than 40 kW in power. CARB staff is also evaluating whether some outboard and personal watercraft vessels could be propelled by zero-emission technologies in certain applications. For example, zero-emission powertrains have the potential to gradually replace most outboard engines less than 19 kW, as well as many new personal watercraft engines. *(Note: CARB has committed to pursue the Spark-Ignition Marine Engine Standards measure, but this measure has not yet been proposed to the Board for approval/adoption)*	No other state has the authority to set exhaust emission and/or evaporative emission standards that exceed the stringency of U.S. EPA's national standards.
New Engine Standards: Off-Highway Recreational Vehicles (OHRVs)	Exhaust Emission Standards for OHRVs (CARB) Evaporative Emission Standards for OHRVs (CARB)	California's emission controls for Off-Highway Recreational Vehicles (OHRVs) are the most stringent in the nation. CARB's exhaust emission standards control emissions from off-highway motorcycles, all-terrain vehicles, and utility terrain vehicles at more stringent levels than applicable national standards set by U.S. EPA for MY 2022 – 2027+. CARB evaporative emission standards harmonize with federal limits for MY 2020 – 2026. California's evaporative emission standards will exceed the stringency of federal requirements for MY 2027+.	No other state has the authority to set exhaust emission and/or evaporative emission standards that exceed the stringency of U.S. EPA's national standards.
In-Use Emissions Controls: Fleet Rules (Off-Highway Recreational Vehicles)	OHRV "Red Sticker" program (CARB)	California's in-use emission controls for Off-Highway Recreational Vehicles (OHRVs) are the most stringent in the nation. CARB's "Red Sticker" program requires in-use OHRVs that do not meet the applicable exhaust emission standards display a red registration sticker that limits operation at certain off highway recreational vehicle parks located in nonattainment areas during peak ozone season.	No other state or nonattainment area controls in-use emissions from OHRV more stringently than CARB.
New Engine Standards: Small Off-Road Engines (SORE)	Exhaust and Evaporative Standards for Small Off-Road Engines (CARB)	California's emission controls for small off-road engines (SORE) are the most stringent in the nation. CARB's current SORE program (through MY 2023) aligns the exhaust and evaporative standards for SORE with federal standards, and sets requirements for Zero-Emission SORE equipment. CARB further increased the stringency of emission controls with the 2021 Amendments to the SORE Regulations, which will accelerate the deployment of zero-emission technologies, set tighter exhaust and evaporative emission standards (MY 2024+), and enhance enforcement of current emission standards for SORE. Beginning in MY 2024,	No other state has the authority to set exhaust emission and/or evaporative emission standards that exceed the stringency of U.S. EPA's national standards.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
		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: *Transport Refrigeration Units (TRU) Regulation Part 2 measure (CARB)*	California's emission controls for Transport Refrigeration Units (TRU) are the most stringent in the nation. CARB adopted the Airborne Toxic Control Measure (ATCM) for In-Use Diesel-Fueled TRUs and TRU Generator Sets, and Facilities Where TRUs Operate (TRU ATCM) in 2004 and amended it in 2010 and 2011 to reduce diesel particulate matter (PM) emissions and resulting health risk from diesel-powered TRUs used to control the environment of temperature-sensitive products. In 2022, CARB further amended the TRU ATCM (2022 Amendments), which included requirements that MY 2023 and newer trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines shall meet a PM emission standard of 0.02 grams per brake horsepower-hour or lower (aligns with the United States Environmental Protection Agency Tier 4 final off-road PM emission standard for 25-50 horsepower engines). CARB is anticipated to further increase the stringency of in-use emission controls on TRUs via the Transport Refrigeration Units Regulation Part 2 measure, which would be designed to require zero-emission trailer TRUs, domestic shipping container TRUs, railcar TRUs, and TRU generator sets. *(Note: CARB has committed to pursue the Transport Refrigeration Unit Regulation Part 2 measure, but this measure has not yet been proposed to the Board for approval/adoption)*	No other state or nonattainment area requires as stringent of emission standards for TRUs
In-Use Emission Controls (Fleet Standard): Transport Refrigeration Units (TRU)	Air Toxic Control Measure for Transport Refrigeration Units and TRU Generator Sets (CARB) Future measure: *Transport Refrigeration Units (TRU) Regulation Part 2 measure (CARB)*	California's in-use emission controls for Transport Refrigeration Units (TRUs) are the most stringent in the nation. CARB adopted the Airborne Toxic Control Measure (ATCM) for In-Use Diesel-Fueled TRUs and TRU Generator Sets, and Facilities Where TRUs Operate (TRU ATCM) in 2004 and amended it in 2010 and 2011 to reduce diesel particulate matter (PM) emissions and resulting health risk from diesel-powered TRUs used to control the environment of temperature-sensitive products. In 2022, CARB further amended the TRU ATCM (2022 Amendments), which included Zero-emission truck TRU fleet requirements. Beginning December 31, 2023, TRU owners shall turnover at least 15 percent of their truck TRU fleet (defined as truck TRUs operating in California) to ZE technology each year (for seven years). All truck TRUs operating in California shall be ZE by December 31, 2029. CARB is anticipated to further increase the stringency of in-use emission controls on TRUs via the TRU Regulation Part 2 measure, which would be designed to require zero-emission trailer TRUs, domestic shipping container TRUs, railcar TRUs, and TRU generator sets. *(Note: CARB has committed to pursue the Transport Refrigeration Unit Regulation Part 2 measure, but this measure has not yet been proposed to the Board for approval/adoption)*	No other state or nonattainment area controls in-use emissions from TRUs more stringently than CARB.
Primarily Federally and Internationally Regulated Sources			
New Engine Standards: Locomotives	Tier 4 NOx and PM Locomotive emission standards (U.S. EPA)	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. *(2016 State SIP Strategy's More Stringent National Locomotive Emission Standards measure)*	requirements for remanufactured locomotives (by ~2020) *(NOTE: CARB has petitioned U.S. EPA for more stringent locomotive standards given the needs in California's nonattainment areas, but approval/adoption of this MSM rests exclusively with U.S. EPA and is thus beyond the purview of CA.)*	
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: • 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: *Future Measures for Aviation Emission Reductions (CARB)*	Future Measures for Aviation Emissions Reductions would reduce emissions from airport and aircraft related activities, including main aircraft engines, auxiliary power units (APU), and airport ground transportation. Due to U.S. EPA's authority on setting emission standards, for this measure, CARB would strongly advocate for stricter emission regulations and highlight the need to reduce pollution to protect public health.	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			
		CARB would also explore requiring all larger airports to perform a comprehensive and standardized emission inventory. An accurate emission inventory that reflects all on-ground and near-ground emissions would establish a baseline and enable verifiable and quantifiable future emissions reductions. CARB would continue to assess technology development for the aviation sector. The purpose is to help inform and support CARB planning, regulatory, and voluntary incentive efforts. Concurrently, CARB would support, track, and explore current, in-development, and future emission reduction technology advancements. CARB would evaluate federal, State, and local authority in setting operational efficiency practices to achieve emissions reductions. Operational practices include landing, takeoff, taxi, and running the APU, and contribute to on-ground and near-ground emissions. CARB would similarly work with U.S. EPA, air districts, airports, and industry stakeholders in a collaborative effort to develop regulations, voluntary measures and incentive programs. *(Note: CARB has committed to pursue the Future Measures for Aviation Emission Reductions, but this measure has not yet been proposed to the Board for approval/adoption)*	
Fuels			
Fuels Standards: Diesel Standards	CARB Diesel Fuel Regulations and Ultra Low Sulfur Diesel (CARB) Future measure: *Low Emission Diesel measure (CARB)*	California's fuel standards for diesel are the most stringent in the nation. CARB Diesel Fuel Regulations include stringent requirements for fuel mixture specifications for aromatic hydrocarbons and sulfur, and have establish a lubricity standard and applies to sales of fuel used in on-road vehicles and off-road vehicles and locomotives in California. CARB's ULSD program reduces NOx and PM emissions significantly relative to U.S. EPA requirements, providing approximately 7 percent more NOx reductions and 25 percent more PM reductions than federal diesel. CARB is anticipated to further increase the stringency of controls on criteria pollutant emissions diesel products. *(NOTE: CARB has committed to pursue the Low Emission Diesel measure, but it has not yet been proposed to the Board for approval/adoption.)*	No state requires cleaner burning diesel than California. The California diesel fuel regulations exceed federal requirements in stringency. CARB staff are aware of only one other state, Texas, who has a boutique diesel fuel program that is approved into the SIP. An independent analysis of The Texas Low Emission Diesel program (TxLED) showed that the TxLED fuel emissions performance does not provide as significant of emission reduction benefits as the California specifications.

Type of Control Measure	Most Stringent Control Program Identified	Summary of Findings from Analysis	Other Jurisdiction(s) Analyzed
Off-Road Mobile Sources			
Fuels Standards: Alternative Fuel Standards (Diesel substitutes)	Low Carbon Fuel Standard (LCFS) (CARB) Alternative Diesel Fuel Regulation (ADF) (CARB)	California's fuel standards for diesel substitutes are the most stringent in the nation. The LCFS and ADF regulations work together to reduce the carbon intensity of the California fuel supply while requiring limits on criteria emissions from alternative fuels and/or alternative fuel mix blends. The LCFS regulation supports alternative fuels used in several off-road applications. However, the program does not apply to fossil jet fuel, aviation gasoline, fuels used in interstate locomotives or fuels used for propulsion of ocean-going vessels.	No other state has set criteria emission requirements on alternative fuels and alternative fuel blends. The Federal Renewable Fuel Standard (RFS II) does not specify criteria requirements for alternative fuels. Other states with low carbon fuel and/or clean fuel programs: • Oregon, Washington, and British Columbia have low carbon fuel standard programs, California participates in the Pacific Coast Collaborative with these states/provinces. • Other states that are considering a clean fuel regulation include: NY, MI, MN, NM, VT, IL, MA.

EMISSION STANDARDS FOR NEW ENGINES AND EQUIPMENT

Off-Road Equipment (General)

CARB ***Tier 4 Off-Road Equipment Standards are*** nearly identical to those finalized by U.S. EPA in its Clean Air Nonroad Diesel Rule. These regulations require engine manufacturers to meet aftertreatment-based exhaust standards for PM and NOx starting in 2011 that are over 90 percent lower than the previous engine generation's emission levels. CARB's new engine standards for off-road equipment is thus aligned with most stringent control program of any in the nation.

Due to constraints in the Act, California is the only state that can set new engine standards (including control measures such as emission standards, sales mandates, warranty provisions, and OBD requirements) that are more stringent than U.S. EPA's national standards. Other states can adopt California programs for which U.S. EPA has provided California with authorizations. While the Act allows other states to adopt CARB's regulations for off-road engine or off-road vehicles (provided that such standards are identical to the CARB standards for which an authorization has been obtained), other states have not yet adopted off-road engine emission standards equivalent to the California off-road regulation, although there are some states currently considering doing so.

CARB has also committed to increase the stringency of off-road equipment emission standards with the ***Tier 5 Off-Road Vehicles and Equipment measure*** and the ***Off-Road Zero-Emission Targeted Manufacturer Rule measure***. Under the Tier 5 Off-Road Vehicles and Equipment measure, CARB would develop and propose standards and test procedures for new off-road CI engines More stringent PM and NOx standards for engines greater than or equal to 56 kW (75 hp). The Off-Road Zero-Emission Targeted Manufacturer Rule would accelerate the development and production of zero-emission off-road equipment and powertrains into more sectors.

IN-USE EMISSION CONTROLS FOR OFF-ROAD ENGINES AND EQUIPMENT

Fleet Rules: Off-Road Equipment (General)

In aggregate, CARB's fleet requirements for off-road equipment are the most stringent in the nation. CARB's ***Cleaner In-Use Off-Road Equipment Regulation (Off-Road Regulation)*** controls diesel PM and NOx emissions from >150,000 in-use offroad engines by requiring their owners to retire, replace, or repower older engines, and/or installing verified exhaust retrofit control technologies to BACT-equivalent engines. Additionally, all vehicles are reported and labeled, and older, dirtier vehicles are restricted from entering fleets.

CARB's Off-Road Regulation controls emissions from aerial lifts, aircraft tugs, backhoes, baggage tugs, belt loaders, cargo loaders, crawler tractors (such as bulldozers), excavators, forklifts, graders, loaders, mowers, rollers, rough terrain forklifts, rubber tired loaders, scrapers, skid steer loaders, snow blowers, tractors, trenchers, as well as several types of on-road vehicles, such as two-engine vehicles, and workover rigs. Furthermore, CARB has also committed to further emission reductions from the off-road equipment fleets through the ***Clean Off-Road Fleet Recognition Program*** measure, which would create a non-monetary incentive to encourage off-road fleets to go above and beyond existing regulatory fleet rule compliance and adopt advanced technology equipment with a strong emphasis on zero-emission technology.

Some nonattainment areas have fleet requirements that also require BACT-equivalent levels of controls for some off-road equipment (i.e. construction equipment), which are described below.

- New York City's Local Law 77 requires use of ultra-low sulfur diesel fuel and BACT for reducing emissions from non-road equipment above 37 kW used on city construction projects.
- Chicago (IL) Clean Diesel Construction Ordinance bans high-polluting diesel equipment from City construction sites. While the California program requires fleets to turnover to Tier 4 or equivalent control levels, the Chicago ordinance only requires fleets to turnover to Tier 2 or equivalent control levels (on-road vehicles MY 1998 and earlier and pre-US Environmental Protection Agency Tier 1 equipment will be banned under the Chicago ordinance.)

No other state or nonattainment area controls in-use off-road equipment fleets more stringently than CARB. Neither of the New York or Chicago programs cover the full suite of off-road equipment engine types and applications that are regulated under CARB's program. Additionally, they do not have as stringent of labeling and reporting requirements as CARB. Finally, the use of ULSD in off-road equipment in New York provides significantly less emission reductions than the use of ULSD inside of California (as is required – see fuels section for more information), as federal USLD specifications allow significantly less stringent caps on sulfur and aromatic hydrocarbon content in fuels than CARB diesel specifications.

OFF-ROAD ENGINES AND EQUIPMENT: SOURCE-SPECIFIC RULES

Beyond the regulations that apply to the majority of the off-road category, CARB also controls sub-categories of off-road equipment through source-specific emission standards and fleet requirements, as described below.

Agricultural Equipment

Emission Standards for Agricultural Equipment

CARB's new engine standards for off-road agricultural equipment (ag equipment) is consistent with the most stringent of any in the nation. In 2004, U.S. EPA and California adopted equivalent ***Tier 4 Off-Road Engine Emission Standards***, which includes requirements for agricultural equipment engines. Beyond the Off-Road Regulation, CARB also controls sub-categories of off-road equipment through specific fleet requirements, as described below.

In-Use Controls: Agricultural Equipment

CARB's agricultural equipment fleet controls are among the most stringent in the nation. The 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 Strategy[115] 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 PM2.5) to 15 ppm, yet CARB's fuel emits ~25 percent less PM. Given that federal off-road ULSD sulfur content is capped at levels 3,000 percent higher than CARB's ULSD, the California program is significantly more stringent in terms of its ability to control emissions of sulfur oxide emissions.
- In addition, CARB controls hydrocarbons and aromatics, unlike U.S. EPA requirements.
- Furthermore, CARB is anticipated to further increase the stringency of controls on criteria pollutant emissions diesel products under the Low Emission Diesel measure committed to in the State SIP Strategy.

As was discussed in the on-road diesel fuel section, only one other state has a boutique fuel program with requirements that differ from federal specifications, the Low Emission Diesel Program in Texas (TxLED). An independent analysis of TxLED, CARB ULSD and federal ULSD shows that the TxLED fuel emissions performance does not provide as significant of emission reduction benefits as the California specifications.[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/m³ Annual (2012)
Off-Road Control Standards (General)		
Off-Road New Vehicle, Equipment and Engine Standards (General)		
Tier 4 Off-Road Engine Emission Standards	ongoing	MSM
Tier 5 Off-Road Vehicles and Equipment (2022 State SIP Strategy measure with commitment)	2029	MSM
California's emission standards for off-road diesel engines are consistent with those of U.S. EPA and the most stringent in the nation, with NOx limits at 0.3 g/bhp-hr, and PM limits at 0.015 g/bhp-hr. With the Tier 5 Off-Road Vehicles and Equipment Measure, CARB has committed to develop and propose standards and test procedures for new off-road CI engines More stringent PM and NOx standards for engines greater than or equal to 56 kW (75 hp). It is expected that Tier 5 requirements would rely heavily on technologies manufacturers are developing to meet the recently approved low-NOx standards and enhanced in-use requirements for on-road- heavy-duty engines. With the commitment to adopt Tier 5 emission standards, California's control program for new off-road engines will be further lowered to a nation-leading level; these levels will be technology-forcing, and will take years of lead time to enable manufacturers sufficient time to develop, test, certify, and manufacture the necessary low-emission engines and components. Further increases in stringency are not feasible. New off-road emission standards for new vehicles and engines are dependent on technological developments, and require years of lead time to be developed, certified, manufactured, and implemented; a more accelerated timeline is infeasible.		
Zero-Emission Off-Road New Equipment and Engine Standards (General)		
Off-Road Zero-Emission Targeted Manufacturer Rule (2022 State SIP Strategy measure with commitment)	2031	MSM
The Off-Road Zero-Emission Targeted Manufacturer Rule would accelerate the development and production of zero-emission off-road equipment and powertrains into more sectors (including wheel loaders, excavators, and bulldozers) as technology advancements occur due to existing CARB zero-emission regulations and regulations in the forklifts, cargo handling equipment, off-road fleets, and small off-road engines sectors. As a technology-forcing regulation, the Off-Road Zero-Emission Targeted Manufacturer Rule will accelerate the development and deployment of Zero-Emission off-road engines and powertrains; further increases in stringency are not feasible. Manufacturer sales requirements need years of lead time to be implemented; it would be infeasible to implement on a more accelerated timeframe.		
In-Use Control Measures – Off-Road Fleets (General)		
In-Use Off-Road Diesel-Fueled Fleets Regulation (Off-Road Regulation)	ongoing	MSM
2022 Amendments to the In-Use Off-Road Diesel-Fueled Fleets Regulation (2022 State SIP Strategy measure, adopted November 2022)	2024	MSM
Clean Off-Road Fleet Recognition Program (2022 State SIP Strategy measure with commitment)	2027	MSM
California's in-use emission controls for off-road equipment are the most stringent in the nation. CARB's off-road regulation controls diesel PM and NOx emissions from >150,000 in-use off road engines by requiring their owners to retire, replace, or repower older engines, and/or installing verified exhaust retrofit control technologies. Additionally, all vehicles are reported and labeled, and older, dirtier vehicles are restricted from entering fleets. The 2022 Amendments to the Off-Road Regulation create additional requirements to the currently regulated fleets by targeting the oldest and dirtiest equipment that is allowed to operate indefinitely under the current regulation's structure. The amendments will require fleets to phase-out use of the oldest and highest polluting off-road diesel vehicles in California, starting in 2024, and include changes to enhance enforceability and encourage the adoption of zero-emission technologies. CARB anticipates further emission reductions from the off-road equipment fleets through the Clean Off-Road Fleet Recognition Program measure, which would create a non-monetary incentive to encourage off-road fleets to go above and beyond existing regulatory fleet rule compliance and adopt advanced technology equipment with a strong emphasis on zero-emission technology. Fleet requirements need years of lead time to be implemented for reasons of technological and economic feasibility. As purchasing requirements and fleet turnover cannot happen immediately, it would be infeasible to accelerate the implementation schedule for new purchasing requirements. California's currently committed to off-road fleet requirements are technology-forcing and are the most stringent in the nation, requiring the lowest-emitting internal combustion engine and equipment technology, with zero-emission elements; further increases in stringency are not feasible.		
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	ongoing	MSM
U.S. EPA and California adopted equivalent Tier 4 standards in 2004 that require additional emission reductions from off-road engines, including those used in mobile agricultural equipment. No State has more stringent requirements for new emission performance standards for agricultural equipment engines than California. Further increases in stringency, or an accelerated timeline for implementation are not feasible.		
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: • 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/m³ Annual (2012)
Amendments to CHE Regulation (2022 State SIP Strategy measure with commitment)	2026	MSM
California's emission controls for Cargo Handling Equipment (CHE) are the most stringent in the nation. CARB's Cargo Handling Equipment regulation sets performance standards for newly acquired engines, as well as in-use mobile CHE at ports or intermodal rail yards. The CHE regulation also includes performance standards for in-use, mobile CHE at ports or intermodal rail yards in California. CARB is anticipated to further increase the stringency of the CHE Regulation by transitioning CHE to zero-emission beginning in 2026. As committed to in the 2022 State SIP Strategy, CARB's amendments to the Cargo Handling Equipment Regulation would set in-use requirements for diesel cargo handling equipment at ports and rail yards, including but not limited to: yard trucks (hostlers), rubber-tired gantry cranes, container handlers, and forklifts. CARB's control measures are the most stringent in the nation, and the requirements committed will be technology-forcing and the most stringent feasible, including zero-emission requirement; further increases in stringency are not feasible. New standards for CHE are dependent on technological developments, and require years of lead time to be developed, certified, manufactured, and implemented; a more accelerated timeline is infeasible.		
Commercial Harbor Craft (CHC)		
Commercial Harbor Craft (CHC) Regulation	ongoing	MSM
2022 Amendments to CHC Regulation 2022 State SIP Strategy measure, adopted May 2022)	ongoing	MSM
California's emission controls for commercial harbor craft (CHC) are the most stringent in the nation. As amended in 2011, CARB's CHC Regulations reduce NOx and diesel PM emissions from crew and supply boats, ferries, excursion vessels, towboats, push boats, tugboats, barges, and dredges, and included in-use limits that required diesel PM and NOx emission controls. CARB amended the CHC regulation in 2022, establishing expanded and more stringent in-use requirements to cover more vessel categories including all tank barges, pilot vessels, research vessels, workboats, commercial passenger fishing, and commercial fishing vessels. The amendments also mandate accelerated deployment of zero-emission and advanced technologies in vessel categories where technology feasibility has been demonstrated. CARB's CHC control measures are technology forcing and the most stringent in the nation; further increases in stringency are infeasible. The requisite technology developments need years of lead time for development, certification, and implementation; it is not technologically feasible to accelerate the implementation timeline.		
Forklifts		
Tier 4 Off-Road Engine Emission Standards	ongoing	MSM
In-Use LSI Engine Fleet Requirements	ongoing	MSM
In-Use Off-Road Diesel-Fueled Fleets Regulation (Off-Road Regulation)	ongoing	MSM
Zero-Emission Off-Road Forklift Regulation Phase 1 (2016 State SIP Strategy measure with commitment)	2026	MSM
Amendments to the CHE Regulation (2022 State SIP Strategy measure with commitment)	2026	MSM
Off-Road Zero-Emission Targeted Manufacturer Rule (2022 State SIP Strategy measure with commitment)	2031	MSM
California's emission controls for forklifts are the most stringent in the nation. Forklifts powered by LSI engines (gasoline and natural gas) are subject to new engine standards that include both criteria pollutant and durability requirements. Diesel Forklifts > 25 HP are subject to Tier 4 Final emission standards (based on the use of advanced after-treatment technologies such as diesel particulate filters and selective catalytic reduction). Under the 2022 Amendments to the In-Use Off-Road Diesel Fueled Fleets Regulation, forklifts are also subject to requirements begin to transition fleets from the oldest and highest-emitting off-road engines in operation in California by phasing out Tier 0 – Tier 2 equipment beginning in 2024. Also beginning in 2024, the regulation includes requirements to restrict the addition of new vehicles and/or engines with Tier 3 and 4i engines. CARB is anticipated to further increase the stringency of emission controls: • The Zero-Emission Off-Road Forklift Regulation Phase I measure would be designed to accelerate the deployment of zero-emission forklift technologies, with an implementation schedule beginning in 2026; • For forklifts operating at ports and intermodal rail yards, the Amendments to the Cargo Handling Equipment Regulation measure that CARB committed to in the 2022 State SIP Strategy measure would also require transitioning to zero-emission technologies. Staff anticipates that all forklifts operating at ports and intermodal rail yards would be zero-emission by 2030; • The Off-Road Zero-Emission Targeted Manufacturer Rule measure would further increase the stringency of emission controls for forklifts, transitioning more fully to zero-emission powertrains.		

Measures	Implementation Begins	12 µg/m³ Annual (2012)
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		
Marine Engines		
Exhaust Emission Regulation for Spark-Ignition Marine Engines	ongoing	MSM
Tier II Emission Standards for Inboard and Stern-Drive Marine Engines	ongoing	MSM
Marine Engine Evaporative Emission Control Standards	ongoing	MSM
Amendments to Spark-Ignition Marine Engine Standards (2022 State SIP Strategy measure with commitment)	2031	MSM
CARB's recreational boats and marine engine program exceeds the stringency of U.S. EPA's federal standards and are the most stringent in the nation: • The Exhaust Emission Regulations for Spark-Ignition Marine Engines (1998) controls emissions at the same level of stringency as national regulations; • The Tier II Emission Standards for Inboard and Stern Drive Marine Engines (2001) controls emissions at the same level of stringency as national regulations; and • The Evaporative Emission Control Standards (2015) exceeds the stringency of applicable federal regulations set by U.S. EPA in 2008 for gasoline-fueled SI marine watercraft >30 kilowatts. The Spark-Ignition Marine Engine Standards measure would reduce emissions from new spark-ignition (SI) marine engines by adopting more stringent exhaust standards for outboard and personal watercraft, which currently do not use catalyst control technologies. Staff estimates that stricter standards could reduce combined HC or ROG and NOx emissions by approximately 70 percent below the current HC+NOx standard. CARB staff is also evaluating whether some outboard and personal watercraft vessels could be propelled by zero-emission technologies in certain applications. California's control program for marine engines is currently the most stringent in the nation, and will be further lowered with the Spark-Ignition Marine Engine Standards measure; these levels will be technology-forcing, and will take years of lead time to enable manufacturers sufficient time to develop, test, certify, and manufacture the necessary low-emission engines and components. Further increases in stringency are not feasible. New marine engine emission standards are dependent on technological developments, and require years of lead time to be developed, certified, manufactured, and implemented; a more accelerated timeline is infeasible.		
Off-Highway Recreational Vehicles (OHRV)		
Exhaust and Evaporative Emission Standards for OHRVs	ongoing	MSM
California's emission controls for Off-Highway Recreational Vehicles (OHRVs) are the most stringent in the nation. CARB's exhaust emission standards and evaporative emission standards control emissions from motorcycles, all-terrain vehicles, and utility-terrain vehicles at more stringent levels than applicable national standards set by U.S. EPA for MY 2022 – 2027+. CARB evaporative emission standards harmonize with federal limits for MY 2020 – 2026, and will exceed the stringency of federal requirements for MY 2027+. CARB's "Red Sticker" program requires in-use OHRVs that do not meet the applicable exhaust emission standards display a red registration sticker that limits operation at certain off highway recreational vehicle parks located in nonattainment areas during peak ozone season. CARB's OHRV program is the most stringent in the nation; further increases in stringency or an accelerated implementation timeframe are not feasible.		
Small Off-Road Engines		
SORE Exhaust Emission Standards and Test Procedures	ongoing	MSM
Evaporative Emission Standards for SORE	ongoing	MSM
2021 Amendments to the Small Off-Road Engines (SORE) Regulation	2024	MSM
California's emission controls for small off-road engines (SORE) are the most stringent in the nation. CARB's current SORE program (through MY 2023) aligns the exhaust and evaporative standards for SORE with federal standards, and sets requirements for Zero-Emission SORE equipment. CARB further increased the stringency of emission controls with the 2021 Amendments to the SORE Regulations, which will accelerate the deployment of zero-emission technologies, set tighter exhaust and evaporative emission standards (MY 2024+), and enhance enforcement of current emission standards for SORE. Beginning in MY 2024, exhaust and evaporative emission standards were lowered to zero, except for pressure washers with engine displacement greater than or equal to 225 cubic centimeters and generators (phase-in for ZE pressure washers and generators begins in MY 2028 and 2024, respectively). As a technology-forcing regulation, the SORE Regulation will accelerate the development and deployment of zero-emission SORE; further increases in stringency are not feasible. New exhaust and evaporative emission standards need years of lead time to be implemented; it would be infeasible to implement on a more accelerated timeframe.		
Transport Refrigeration Units (TRUs)		

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
California's emission controls for Transport Refrigeration Units (TRU) are the most stringent in the nation. Amended in 2022, the TRU ATCM requires that MY 2023 and newer trailer TRU, DSC TRU, railcar TRU, and TRU generator set engines meet a PM emission standard of 0.02 grams per brake horsepower-hour or lower (aligns with the United States Environmental Protection Agency Tier 4 final off-road PM emission standard for 25-50 horsepower engines). Beginning December 31, 2023, TRU owners shall turnover at least 15 percent of their truck TRU fleet (defined as truck TRUs operating in California) to ZE technology each year (for seven years). All truck TRUs operating in California shall be ZE by December 31, 2029. CARB has committed to increasing the stringency of TRU controls with the TRU Regulation Phase 2, which would establish zero-emission options for non-truck TRUs. These levels will be technology-forcing, and will take years of lead time to enable manufacturers sufficient time to develop, test, certify, and manufacture the necessary low-emission engines and components. Further increases in stringency are not feasible. New emission standards and zero-emission requirements for TRUs are dependent on technological developments, and require years of lead time to be developed, certified, manufactured, and implemented; a more accelerated timeline is infeasible.		
In-Use Emission Control Measures for Primarily Federally and Internationally Regulated Sources		
In-Use Railroad Control Measures		
Statewide Rail Yard Agreement for California Rail Yards (Railroad MOU)	ongoing	MSM
In-Use Locomotive Regulation (2022 State SIP Strategy measure, adopted April 2023)	2024	MSM

U.S. EPA has the sole authority to establish emissions standards for locomotives. California's in-use emission reduction measures for locomotives are the most stringent in the nation. The 2005, Statewide Rail Yard Agreement for California Rail Yards, a Memorandum of Understanding (MOU) with the Class I Railroads to increase the use of idle control devices, lowered locomotive idle times to 15 minutes, and opened a collaboration to produce Health Risk Assessments on 18 major railyards in the state was completed in 2015. Adopted in April 2023, the In-Use Locomotive Regulation accelerates the adoption of advanced, cleaner technologies for locomotive operations, including zero-emission technologies. The regulatory elements include:

- Starting in 2024: Spending Account
  Locomotive operators would be required to fund their own trust account based on the emissions created by their locomotive operations in California. The dirtier the locomotive, the more funds must be set aside. Spending Account funds would be used to fund turnover to cleaner locomotives, rail equipment, and/or related infrastructure.
- Starting in 2024: Idling Limit
  All locomotives with automatic shutoff devices (AESS) would not be permitted to idle longer than 30 minutes, unless for an exempt reason. Exemptions closely align with those described by U.S. EPA., and would be granted for reasons like maintaining air brake pressure or to perform maintenance.
- Starting in 2030: In-Use Operational Requirements
  Only locomotives less than 23 years old would be able to be used in California. Switchers, industrial, and passenger locomotives with original engine build dates of 2030 or newer would be required to operate in a ZE configuration in California. Freight line haul locomotives with original engine build dates of 2035 and newer would be required to operate in a ZE configuration in California.

CARB's in-use emission controls for locomotives are the most stringent in the country, and with the In-Use Locomotive Regulation, which includes zero-emission elements, stringency will be increased further; these requirements are technology-forcing and additional increases in stringency are not feasible. Fleet requirements need years of lead time to be implemented; it would be infeasible to accelerate the implementation timeframe.

In-Use Aviation Control Measures		
Future Measures for Aviation Emission Reductions (2022 State SIP Strategy measure with commitment)	2029	MSM

The authority to establish emissions standards for aircraft lies at the federal level; no state has emission standards for aircraft that differ from those set by U.S. EPA and the FAA. CARB's Future Measures for Aviation Emissions Reductions would reduce in-use emissions from airport and aircraft related activities, including main aircraft engines, auxiliary power units (APU), and airport ground transportation. These emission control strategies would be nation-leading in terms of stringency; further increases in stringency are not feasible. These strategies are also dependent on technological and operational developments, and require sufficient lead time for regulated parties to comply; an accelerated implementation timeline would not be feasible.

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
CARB's Ultra Low Sulfur Diesel regulation was last amended 2003 to establish more stringent standards for diesel fuel, lowering the sulfur limit to 15 ppmw. The California Diesel Fuel Regulations apply to essentially all diesel fuel supplied, sold, or offered for sale in California. The original applicability of the regulations was to vehicular diesel fuel; however, the applicability of the regulations has been extended by the adoption of ATCMs to non-vehicular diesel fuel, such as fuel for stationary engines, locomotives, and marine harbor craft. The Low Emission Diesel measure would require diesel fuel providers to steadily decrease criteria pollutant emissions from their fuels, which will reduce NOx and PM tailpipe emissions. CARB fuel regulations reduce emissions from even those vehicles registered out of state and therefore not subject to CARB's other mobile source control measures. CARB's diesel standards and requirements are the most stringent in the nation, and some of the most stringent in the world; it is not feasible to require further stringency of fuel specifications.		
Alternative Fuel Standards		
Low Carbon Fuel Standard (LCFS)	ongoing	MSM
Alternative Diesel Fuel (ADF)	ongoing	MSM
California's fuel standards for diesel substitutes are the most stringent in the nation. The LCFS and ADF regulations work together to reduce the carbon intensity of the California fuel supply while requiring limits on criteria emissions from alternative fuels and/or alternative fuel mix blends (due to regulatory constraints, the LCFS and ADF do not apply to aviation gasoline, nor fuels used in interstate locomotives and ocean-going vessels – regulatory control over these fuels lies at the national and international level). The regulations were amended in 2018 to extend the carbon intensity target of 20 percent to 2030. No other state or federal requirements have set as stringent of criteria emission requirements on alternative fuels and alternative fuel blends than California. The LCFS and ADF are technology-forcing regulations, and are the most stringent in the nation; further stringency would not be feasible. As it takes fuel producers years to develop, certify, and manufacture new alternative fuel types to meet the increasingly stringent requirements of the LCFS and ADF, an accelerated implementation timeframe would not be feasible.		

STEP 3(B): EVALUATION OF FEASIBILITY: OFF-ROAD CONTROL MEASURES

Step 3(b) calls for an assessment of the feasibility of implementing any measure that is not included in the 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 NOx 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			
Space and Water Heaters			
Emission standard (new sales): Zero-Emission Standard for Space and Water Heaters	Future measure: Zero-emission Standard for Space and Water Heaters (CARB)	CARB's Zero-Emission Standard for Space and Water Heaters measure is the most stringent standard of its type at the state level. This measure would reduce emissions from new residential and commercial space and water heaters sold in California. CARB would set an emission standard for space and water heaters to go into effect in 2030. CARB would adopt a statewide zero-emission standard which would have criteria pollutant benefits as a key result along with GHG reductions. Beginning in 2030, 100 percent of sales of new space heaters and water heaters would need to comply with the emission standard. *(Note: CARB has committed to pursue the Zero-Emission Standard for Space and Water Heaters measure, but this measure has not yet been proposed to the Board for approval/adoption)*	No other state has emission standards that require space and water heaters sales to be exclusively zero-emission by 2030. Maryland passed the Climate Solutions Now Act, establishing Building Energy Performance Standards for buildings 35,000 square feet and larger to achieve a 20 percent reduction in net direct greenhouse gas (GHG) emissions by 2030 and net-zero emissions by 2040. The regulation also requires holistic retrofits of low-income households, including weatherization and heat pump installations.[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.nyserda.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_Equitable%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
With the Zero-Emission Standard for Space and Water Heaters measure, CARB would set a statewide zero-emission standard for space and water heaters. Beginning in 2030, 100 percent of the sales of new space heaters and water heaters would need to comply with the emission standard. This standard would be the most stringent of any state in the U.S., and would exceed the stringency of Federal requirements; further increases in stringency are not feasible. New zero-emission standards take years of lead time to ensure manufacturers have sufficient time to implement the necessary changes in their business models and to scale up production to a sufficient level to meet the demand produced by a Statewide standard; a more accelerated timeline is not feasible		

STEP 3(B): EVALUATION OF FEASIBILITY: COMMERCIAL AND RESIDENTIAL BUILDING APPLIANCES CONTROL MEASURES

Step 3(b) calls for an assessment of the feasibility of implementing any measure that is not included in the 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 PM2.5 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 PM2.5 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 μg/m^3 annual PM2.5 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 μg/m^3 annual PM2.5 standard – including the control measures described in the 2022 State SIP Strategy – will satisfy the requirements of Step 4.

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.

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Chapter 4

PRECURSOR DEMONSTRATION

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TABLE OF CONTENTS

TABLE OF FIGURES

TABLE OF TABLES

Chapter 4: Precursor Demonstration for Ammonia, SOx, and ROG

[This section provided by California Air Resources Board]

4.1 INTRODUCTION

Fine particulate matter (PM2.5) is made up of many constituent particles that are either directly emitted, such as soot and dust, or formed through complex reactions of gases in the atmosphere. Oxides of nitrogen (NOx), sulfur dioxide (SO2), volatile organic compounds (VOCs), and ammonia (NH3) are gases that are precursors to PM2.5, transforming into particles through physical and chemical atmospheric processes.

The United States Environmental Protection Agency (U.S. EPA) finalized a PM2.5 State Implementation Plan (SIP) Requirements Rule[1] (PM2.5 Rule) that identifies the four PM2.5 precursor pollutants—NOx, SO2, VOCs, and ammonia—that must be evaluated for potential control measures in any PM2.5 attainment plan. As described in the PM2.5 Precursor Demonstration Guidance[2] (Guidance) finalized by U.S. EPA in May 2019, the PM2.5 Rule permits air agencies to "submit an optional precursor demonstration designed to show that for a specific PM2.5 nonattainment area, emissions of a particular precursor from sources within the nonattainment area do not or would not contribute significantly to PM2.5 levels that exceed" the national ambient air quality standards (NAAQS). If the agency's demonstration is approved by U.S. EPA, the attainment plan "may exclude that precursor from certain control requirements under the Clean Air Act."

This document includes precursor demonstrations that the California Air Resources Board (CARB) is requesting to be excluded from certain control requirements specified in the Clean Air Act (Act) for three PM2.5 precursors: ammonia (NH3), oxides of sulfur (SOx), and reactive organic gases (ROG). The CARB inventory tracks SOx rather than SO2 specifically, but SOx consists mostly of SO2. ROG is similar, although not identical, to U.S. EPA's term "VOC."[3] CARB's inventory tracks ROG as a subset of total organic gases (TOG). NOx is an important and significant precursor to PM2.5 and is controlled extensively in the SIP. NOx emissions are essential to the attainment strategy for the San Joaquin Valley (Valley).

Following the Guidance, the three precursor demonstrations analyze "the relationship between precursor emissions and the formation of secondary PM2.5 components" using an air quality model, and take into consideration additional relevant factors.

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[1] 81 FR 58010 (August 24, 2016)

[2] U.S. EPA. PM2.5 Precursor Demonstration Guidance. 30 May 2019. https://www.epa.gov/sites/default/files/2019-05/documents/transmittal_memo_and_pm25_precursor_demo_guidance_5_30_19.pdf

[3] See: California Air Resources Board. "FACT SHEET #1: Development of Organic Emission Estimates For California's Emission Inventory and Air Quality Models." Aug. 2000. Web. 24 May 2018. www.arb.ca.gov/ei/speciate/factsheetsmodeleispeciationtog082000.pdf

4.2 U.S. EPA PM2.5 PRECURSOR DEMONSTRATION GUIDANCE

U.S. EPA finalized the Guidance in May 2019 to “assist air agencies who may wish to submit PM2.5 precursor demonstrations.” The Guidance provides recommendations or guidelines, as authorized under the Act, “that will be useful to air agencies in developing the precursor demonstrations by which the U.S. EPA can ultimately determine whether sources of a particular precursor contribute significantly to PM2.5 levels that exceed the standard in a particular nonattainment area.” Recommendations include modeling procedures for conducting the required analysis and contribution thresholds to determine the impact of a precursor on PM2.5 levels. The Guidance also describes an analytical process to perform the precursor demonstration, involving a concentration-based analysis followed by a sensitivity-based analysis and consideration of additional information.

4.2.1 Concentration-Based Analysis

The evaluation of precursors begins with a concentration-based analysis using ambient data to determine whether precursor emissions contribute to total PM2.5 concentrations. Each precursor’s impact on total PM2.5 mass is compared to contribution thresholds. U.S. EPA recommends values for these thresholds, or air quality concentrations below which air quality impacts are not statistically significantly different from “the inherent variability in the measured atmospheric conditions,” and thus do not contribute to PM2.5 concentrations that exceed the NAAQS. These thresholds are ≥0.2 micrograms per cubic meter (µg/m^3) for the annual PM2.5 standard and ≥1.5 µg/m^3 for the 24-hour PM2.5 standard.

As shown below in Table 4-1, based on this metric, ammonia, SO2, and VOCs contribute to total PM2.5 mass in the Valley in amounts that exceed U.S. EPA’s recommended thresholds.

Table 4-1 Contribution of Ammonia, SO2, and VOCs to Total PM2.5

Species	Relevant Precursor	Species Contribution (µg/m^3) to PM2.5 Mass*	Over Threshold?
Ammonium nitrate	Ammonia	4.6	Yes
Ammonium sulfate	SO2 (SOx)	1.1	Yes
Carbonaceous aerosols	VOCs (ROG)	6.5	Yes

* 2017 annual average for Bakersfield-California

This concentration-based analysis, however, does not accurately capture the impact of reductions of precursor emissions on PM2.5 levels. Since the concentration-based analysis shows the precursors contribute to total PM2.5 mass in amounts over U.S. EPA’s recommended thresholds, CARB proceeded to conduct an optional sensitivity-based analysis to demonstrate that reductions of ammonia, SOx, and ROG will have negligible impact on PM2.5 air quality and be excluded from certain control requirements.

4.2.2 Sensitivity-Based Analysis

The PM2.5 Rule allows for a sensitivity-based analysis to examine the degree to which PM2.5 levels are sensitive to precursor reductions. According to the Guidance:

> This modeling analysis examines the sensitivity of ambient PM2.5 concentrations in the nonattainment area to decreases in precursor emissions in the area…. Where decreases in emissions of the precursor result in insignificant air quality impacts (i.e., the area is “not sensitive” to decreases), such a small degree of impact can be considered to not “contribute” to PM2.5 concentrations for the purposes of determining whether control requirements should apply.

U.S. EPA notes in the Guidance that, “where air agencies have both base year and future year modeling in support of an attainment demonstration…, precursor demonstration modeling to demonstrate that precursor emissions do not contribute significantly to PM2.5 concentrations in the nonattainment area could be done in either a base year or a future year.”

For each existing PM2.5 monitor location in the area, the first step for estimating PM2.5 impacts from ammonia, SOx, or ROG in the base year is to estimate the average PM2.5 concentration on an annual basis. The second step is to calculate the annual average PM2.5 concentration at each monitor with a specified percent reduction in precursor emissions, still in the base year. The difference between these two calculated PM2.5 values is the impact on PM2.5 levels from precursor emissions reductions. Note that “precursor demonstrations do not examine changes in emissions between a base year and a future year. Instead, the calculation of changes in PM2.5 concentrations occur between a modeled case with all emissions and a modeled case with reduced precursor emissions.” In addition, U.S. EPA recommends in the Guidance modeling reductions of between 30 and 70 percent of precursor emissions since emission reductions need to be large enough to test the interaction of the precursor. In general, the recommended range is reasonable for SO2 and NOx; however, this range is not reasonable for ammonia. As indicated in the Guidance, between 2011 and 2017, the median changes in SO2 and NOx emissions nationally were decreases of 63.6 and 31.8 percent respectively, while, in contrast, the median change in ammonia was a 0.8 percent increase in emissions. The large reductions in SO2 and NOx emissions are in response to reasonable controls that are available and in practice at sources. The slight increase nationally of ammonia is indicative of the lack of controls on ammonia sources across the nation.

The third step in the sensitivity-based analysis is to compare the modeled impact on PM2.5 levels from a decrease in ammonia, SOx, or ROG emissions to contribution thresholds for annual PM2.5. If the calculated PM2.5 impact is greater than 0.2 $\mu g/m^3$ for the 12 $\mu g/m^3$ annual standard, then PM2.5 levels are sensitive to the modeled percent reduction in ammonia, SOx, or ROG emissions.

4.2.3 Consideration of Additional Information

To supplement modeling analysis, U.S. EPA Guidance also allows an air agency to consider additional information, assessing the significance of a precursor "'based on the facts and circumstances of the area.'" The Guidance states:

> If the estimated air quality impact is greater than or equal to the recommended contribution threshold, this fact does not necessarily preclude approval of the precursor demonstration. There may be cases where it could be determined that precursor emissions have an impact above the recommended contribution thresholds, yet "do not contribute significantly" to levels that exceed the standard in the area.

In these cases, an air agency may provide U.S. EPA with "information related to other factors they believe should be considered in determining whether the contribution of emissions of a particular precursor to levels that exceed the NAAQS is 'significant' or not." Such factors may include trends in emissions of other precursors such as NOx, anticipated growth or loss of emissions sources, and impacts of modeled precursor reductions in a future year rather than the base year. U.S. EPA may also require an evaluation of available emissions controls in support of a precursor demonstration. These factors are discussed in the context of the precursor analyses for the Valley in the subsequent sections.

The following sections contain sensitivity-based analyses and supplemental information demonstrating that ammonia, SOx, and ROG are not significant precursors to PM2.5 in the Valley.

4.3 AMMONIA ANALYSIS

Ammonium nitrate (NH4NO3) is a constituent of PM2.5, making up about 19 percent of fine particulate matter mass in the Valley in 2017. Ammonium nitrate forms when nitrogen dioxide (NO2) reacts with highly oxidizing species in the atmosphere to form nitric acid (HNO3). Nitric acid then reacts with ammonia (NH3) to yield ammonium nitrate as a particle. Since ammonia reacts chemically in this way to form a particle, ammonia is a precursor to PM2.5.

Lowering PM2.5 concentrations to levels that meet the NAAQS will rely upon an effective control strategy for ammonium nitrate. The amount of ammonium nitrate that can form in the atmosphere is limited by whichever precursor, either NOx or ammonia, is in least supply, and research studies confirm that there are relatively fewer NOx molecules in the air in the Valley than ammonia. This implies that reducing NOx, the limiting precursor in this case, is more effective for reducing ammonium nitrate concentrations and thus improving PM2.5 air quality.

Following the analytical process outlined in the Guidance and summarized above, CARB has evaluated ammonia in the Valley. The results of the sensitivity-based analysis and consideration of additional information are presented below.

4.3.1 Sensitivity-Based Analysis

CARB staff used an air quality model to estimate the PM2.5 design value for the annual standard in the base year of 2017 at each Valley monitor. Then, CARB staff applied the recommended lower bound of a 30 percent reduction to ammonia emissions and used the air quality model to estimate the PM2.5 design values, as shown in Table 4-2. The difference between the two design values represents the modeled impact on PM2.5 levels of a 30 percent reduction in ammonia emissions in 2017. This is the value that is compared to U.S. EPA's recommended contribution threshold for the 12 $\mu g/m^3$ annual standard of 0.2 $\mu g/m^3$ to establish if PM2.5 levels are sensitive to this level of ammonia reduction.

Table 4-2 Base Year 2017 PM2.5 – 30 Percent Ammonia Reduction

Site	2017 Baseline DV	2017 DV with 30% Ammonia Reduction	Difference
Bakersfield-Planz	16.97	16.69	0.28
Hanford	15.73	15.52	0.21
Bakersfield-Golden	15.52	15.24	0.28
Visalia	15.43	15.23	0.20
Bakersfield-California	15.12	14.87	0.25
Corcoran	14.95	14.65	0.30
Fresno-Hamilton	13.99	13.85	0.14
Fresno-Garland	13.69	13.58	0.11
Turlock	12.7	12.64	0.06
Clovis	12.69	12.47	0.22
Merced-SCoffee	12.28	12.17	0.11
Stockton	12.21	12.27	-0.06
Madera	12.11	11.94	0.17
Merced-MStreet	11.73	11.63	0.10
Modesto	11.16	11.17	-0.01
Manteca	10.37	10.42	-0.05
Tranquility	8.19	8.08	0.11

For completeness, CARB staff repeated this analysis, applying the U.S. EPA-recommended upper bound of a 70 percent reduction to ammonia emissions in the 2017 base year, as shown in Table 4-3.

Table 4-3 Base Year 2017 PM2.5 – 70 Percent Ammonia Reduction

Site	2017 Baseline DV	2017 DV with 70% Ammonia Reduction	Difference
Bakersfield-Planz	16.97	15.93	1.04
Hanford	15.73	14.53	1.2

Site	2017 Baseline DV	2017 DV with 70% Ammonia Reduction	Difference
Bakersfield-Golden	15.52	14.4	1.12
Visalia	15.43	14.6	0.83
Bakersfield-California	15.12	14.15	0.97
Corcoran	14.95	13.49	1.46
Fresno-Hamilton	13.99	13.34	0.65
Fresno-Garland	13.69	13.1	0.59
Turlock	12.7	12.0	0.7
Clovis	12.69	11.65	1.04
Merced-SCoffee	12.28	11.37	0.91
Stockton	12.21	11.71	0.5
Madera	12.11	11.1	1.01
Merced-MStreet	11.73	11.21	0.52
Modesto	11.16	10.59	0.57
Manteca	10.37	9.94	0.43
Tranquility	8.19	7.57	0.62

From this analysis, the estimated air quality impact of reducing ammonia emissions by the lower bound of 30 percent in the base year equals or exceeds U.S. EPA's recommended annual threshold of 0.2 µg/m^3 at seven Valley monitors. Reducing emissions by the upper bound of 70 percent shows impacts above the threshold at all sites. It is not possible, however, at this point to conclude from this analysis that emissions of ammonia "significantly contribute."

In this case, ammonia emissions have an impact above the recommended contribution thresholds even at the lower bound, but, as the Guidance indicates, this does not necessarily mean the precursor contributes significantly to PM2.5 levels that exceed the NAAQS. Making the appropriate determination about the ammonia emission reduction impact requires further analysis of additional factors.

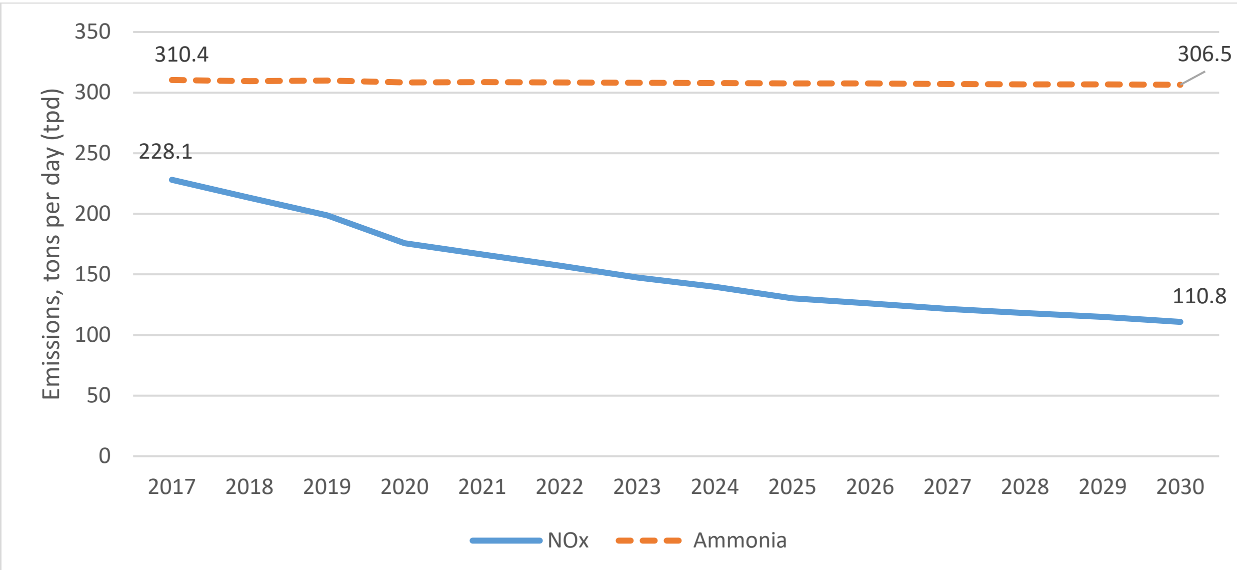
4.3.2 Consideration of Additional Information

To supplement modeling analysis, the Guidance also allows an air agency to consider additional information, assessing the significance of a precursor "'based on the facts and circumstances of the area.'" CARB staff believes that there are several critical factors that must be considered in determining whether ammonia is a significant precursor to PM2.5 in the Valley.

4.3.2.1 Emissions Trends and Studies

CARB has an extensive suite of measures in place to reduce NOx emissions from mobile sources that reduce ammonium nitrate. Between 2017 and 2030, total NOx emissions are expected to decline 117 tons per day (tpd) or 51 percent. Meanwhile, total ammonia emissions are expected to remain flat, declining 3.9 tpd or 1 percent, as shown in Figure 4-1. The San Joaquin Valley Air Pollution Control District (District) adopted four rules[4] between 2004 and 2011 with measures that provided ammonia emissions reductions in the Valley; however, reductions from these existing control measures are already accounted for in the inventory, prior to the base year of 2017. In the future, emissions from the main sources of ammonia—dairies, fertilizer, and non-dairy livestock operations—are not anticipated to either increase or decrease substantially.

Figure 4-1 NOx and ammonia emission trends in the San Joaquin Valley between 2017 and 2030



Source: CEPAM 2022 v 1.00

The steep downward trend of NOx emissions and the stability of ammonia emissions between 2017 and 2030 lead CARB staff to conclude that modeling the impact of ammonia emissions reductions in the future, rather than the base year, is appropriate and more representative of the Valley's emissions conditions. The Guidance states that, in some situations, it may be "more appropriate to model future conditions that provide a more representative sensitivity analysis." This approach is applicable in the Valley. After a 30 percent reduction in ammonia emissions, NOx and ammonia are of roughly similar magnitude in the base year, thereby leading to some modeled sensitivity of PM2.5 levels to a 30 percent reduction in ammonia emissions, these conditions do not persist and are not representative in the future.

As early as the 1995 Integrated Modeling Study (IMS95), in situ measurements in the San Joaquin Valley indicated the region was ammonia-saturated, which supports NOx being the controlling precursor to ammonium nitrate formation (Kumar et al., 1998[5];

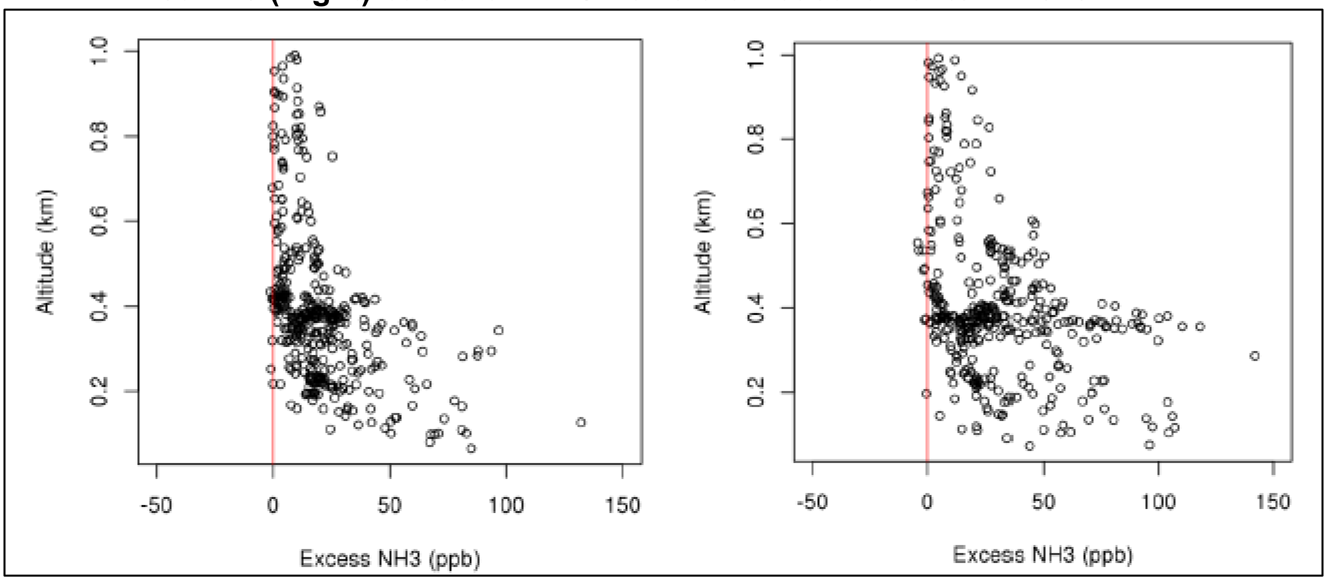
[4] District Rule 4550: Conservation Management Practices (adopted 2004); Rule 4565: Biosolids, Animal Manure, and Poultry Litter Operations (adopted 2007); Rule 4566: Organic Material Composting Operations (adopted 2011); and Rule 4570: Confined Animal Facilities (adopted 2006, amended 2010)

[5] Kumar, N.; Lurmann, F.W.; Pandis, S.; Ansari, A. *Analysis of Atmospheric Chemistry during 1995 Integrated Monitoring Study*; STI-997214-1791-FR; Report prepared for the San Joaquin Valleywide Air Pollution Study Agency, c/o the California Air Resources Board, Sacramento, CA, by Sonoma Technology, Inc.: Petaluma, CA, 1998.

Blanchard et al., 2000[6]). Wintertime measurements five years later during the CRPAQS field study (December 1999 through February 2001) were consistent with the IMS95 findings, where nearly all of the measurements were ammonia-saturated (Lurmann et al., 2006[7]). Lurmann et al. (2006) note that "[t]he consistent excess of NH3 over nitric acid levels indisputably shows that secondary ammonium nitrate formation is more limited by nitric acid availability than NH3 within the SJV and in the foothills."[8]

More recent measurements during the DISCOVER-AQ field campaign in January and February 2013 (Parworth et al., 2017[9]; and Figure 4-2), support previous findings of an ammonia-saturated environment, where a small to moderate reduction in ammonia emissions is likely to have little to no effect on ammonium nitrate concentrations.

Figure 4-2 Excess ammonia (NH3) in the San Joaquin Valley on Jan 18 (Left) and Jan 20 (Right) based on NASA aircraft measurements in 2013



Since ammonium nitrate formation is limited by NOx, reducing NOx emissions is the more effective strategy for reducing ammonium nitrate and PM2.5.

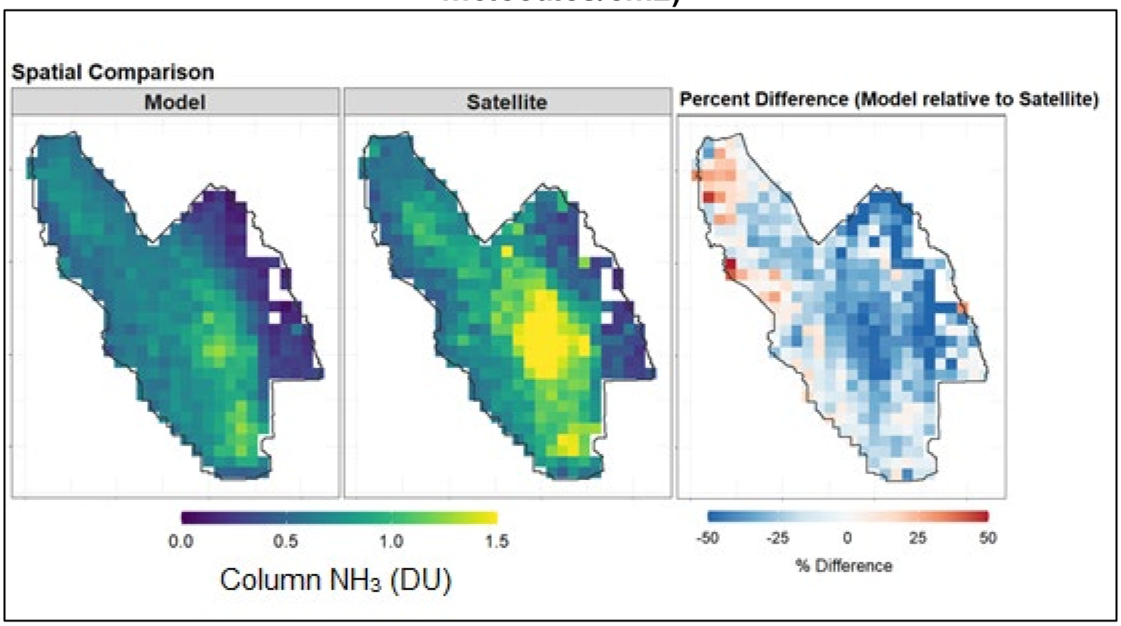
Other research has found that ammonia emission concentrations in the San Joaquin Valley are higher than currently estimated, further confirming that NOx reductions are the most effective path to reducing PM2.5. A 2017 study using satellite data also aligns

[6] Blanchard, C.L.; Roth, P.M.; Tenenbaum, S.J.; Ziman, S.D.; Seinfeld, J.H. The Use of Ambient Measurements to Identify Which Precursor Species Limit Aerosol Nitrate Formation; *J. Air & Waste Manage. Assoc.* 2000, 50, 2073-2084.
[7] Lurmann, F.W.; Brown, S.G.; McCarthy, M.C.; Roberts, P.T. Processes Influencing Secondary Aerosol Formation in the San Joaquin Valley during Winter; J. Air & Waste Manage. Assoc. 2006, 56, 1679-1693, https://doi.org/10.1080/10473289.2006.10464573
[8] Ibid. Page 1688
[9] Parworth, C.L.; Young, D.E.; Kim, H.; Zhang, X.; Cappa, C.D.; Collier, S.; Zhang, Q. Wintertime water-soluble aerosol composition and particle water content in Fresno, California, J. Geophys. Res., 122, 3155-3170, doi:10.1002/2016JD026173

with this previous research. Measurements of column-integrated ammonia[10] taken from the Infrared Atmospheric Sounding Interferometer (IASI), an instrument housed aboard the European Space Agency's MetOP-A satellite which passes over California daily, suggest that CARB's emissions inventory currently underestimates ammonia emissions in the Valley. These results suggest the modeled sensitivity to ammonia reductions is overstated and further reinforces the efforts to develop and deploy ammonia controls would not move the Valley forward on the path to reducing PM2.5 concentrations, and that NOx emissions reductions are the most effective strategy to reduce ammonium nitrate. CARB is continuing to evaluate ammonia emissions and for any updates that are made to the emissions inventory for ammonia in connection with development of future SIPs, CARB staff will hold a public process to solicit public input.

Figure 4-3 shows the annual average of column ammonia in 2017 from IASI (Satellite) and Community Multiscale Air Quality (CMAQ) (Model). The model is biased low for column ammonia in the Valley. This bias is most noticeable in Tulare County, where both the model and satellite show an ammonia hotspot, but the model shows about half as much ammonia as the satellite.

Figure 4-3 Maps of annual average ammonia from CMAQ (Model; left), IASI (Satellite; middle), and the percentage difference (DU, 1 DU = 2.69e16 molecules/cm2)



With these new findings from the 2017 study aligning with previous findings from IMS95, CRPAQS, and DISCOVER-AQ, CARB staff's conclusion based on the scientific analysis available continues to be that focusing on NOx emission reductions is key to improving the health of Valley residents and actions to reduce ammonia will not provide significant PM2.5 air quality improvements.

[10] Column-integrated ammonia is total ammonia in the atmosphere above a specific location, including both surface (ground-level) and aloft. Most column-integrated ammonia is found at the surface.

4.3.2.2 Future Year Modeling

Analysis of NOx and ammonia emissions trends, discussed above, indicated that modeling the impact of ammonia emissions reductions in the future, rather than the base year, is appropriate and more representative of the Valley's emissions conditions. In accordance with the Guidance, CARB staff repeated the sensitivity-based analysis of ammonia for the future attainment year of 2030. Staff used an air quality model to estimate the PM2.5 design value for the annual standard in 2030 at each Valley monitor. Then, CARB staff applied a 30 percent reduction to ammonia emissions and used the air quality model to estimate the PM2.5 design values in 2030, shown in Table 4-4. The difference between the two design values represents the modeled impact on PM2.5 levels of a 30 percent reduction in ammonia emissions in the attainment year. The future-year modeling includes emission reductions from measures in the CARB-adopted 2022 State Strategy for the State Implementation Plan (2022 State SIP Strategy).[11]

Table 4-4 Future Year 2030 PM2.5 – 30 Percent Ammonia Reduction

Site	2030 Baseline DV	2030 DV with 30% Ammonia Reduction	Difference
Bakersfield-Planz	14.05	13.96	0.09
Hanford	11.17	11.01	0.16
Bakersfield-Golden	12.48	12.38	0.1
Visalia	12.41	12.33	0.08
Bakersfield-California	12.39	12.3	0.09
Corcoran	10.71	10.54	0.17
Fresno-Hamilton	11.77	11.7	0.07
Fresno-Garland	11.55	11.49	0.06
Turlock	10.33	10.21	0.12
Clovis	9.91	9.8	0.11
Merced-SCoffee	9.61	9.49	0.12
Stockton	10.7	10.59	0.11
Madera	9.17	9.06	0.11
Merced-MStreet	9.96	9.9	0.06
Modesto	9.3	9.19	0.11
Manteca	8.85	8.75	0.1
Tranquility	6.37	6.29	0.08

For completeness, CARB staff repeated this analysis, applying instead the U.S. EPA-recommended upper bound of a 70 percent reduction to ammonia emissions in 2030, as shown in Table 4-5.

[11] CARB. 2022 State Strategy for the State Implementation Plan. 22 Sept. 2022. https://ww2.arb.ca.gov/sites/default/files/2022-08/2022_State_SIP_Strategy.pdf

Table 4-5 Future Year 2030 PM2.5 – 70 Percent Ammonia Reduction

Site	2030 Baseline DV	2030 DV with 70% Ammonia Reduction	Difference
Bakersfield-Planz	14.05	13.75	0.30
Hanford	11.17	10.66	0.51
Bakersfield-Golden	12.48	12.17	0.31
Visalia	12.41	12.15	0.26
Bakersfield-California	12.39	12.1	0.29
Corcoran	10.71	10.11	0.60
Fresno-Hamilton	11.77	11.53	0.24
Fresno-Garland	11.55	11.34	0.21
Turlock	10.33	9.96	0.37
Clovis	9.91	9.58	0.33
Merced-SCoffee	9.61	9.23	0.38
Stockton	10.7	10.36	0.34
Madera	9.17	8.78	0.39
Merced-MStreet	9.96	9.76	0.20
Modesto	9.3	8.96	0.34
Manteca	8.85	8.54	0.31
Tranquility	6.37	6.12	0.25

From this analysis, in 2030, the modeled air quality impact of reducing ammonia emissions by 30 percent falls under U.S. EPA's recommended threshold of 0.2 μg/m^3 at all Valley monitor sites. The estimated air quality impact of reducing ammonia emissions by the upper bound of 70 percent in 2030 exceeds U.S. EPA's recommended threshold at all sites.

4.3.2.3 Available Emissions Controls

Another factor that may be considered as additional information for this analysis is available emissions controls on ammonia. The availability of ammonia emissions controls is relevant to the decision-making process, influencing the extent of reasonable modeled reductions. While U.S. EPA recommends modeling emissions reductions of between 30 and 70 percent to estimate PM2.5 impacts, these percentage were based on the change seen nationally in NOx and SO2 reductions between 2011 and 2017. During that same time, ammonia emissions increased slightly, indicating limited control opportunities. CARB staff, District staff, and the public process also have not identified specific controls that are technologically and economically feasible to achieve reductions at the low end of the recommended sensitivity range (i.e., 30 percent), much less at the upper end of the range.

At U.S. EPA staff's request, CARB and the District developed a supplemental document on ammonia as a PM2.5 precursor to support the Attainment Plan Revision for the 1997 Annual PM2.5 Standard (15 μg/m^3 SIP Revision) which CARB submitted in 2021. The supplemental document—Ammonia: Supplemental Information for EPA in Support of 15 μg/m^3 Annual PM2.5 Standard (Ammonia Supplemental Information for the 15 μg/m^3

SIP Revision)[12]—expanded on earlier analyses, assessing potential controls on ammonia sources identified by U.S. EPA to analyze the appropriateness of the 30 percent reduction threshold for the precursor analysis, relevant to the 15 µg/m^3 annual PM2.5 standard. CARB submitted the Ammonia Supplemental Information for the 15 µg/m^3 SIP Revision to U.S. EPA in March 2023. U.S. EPA proposed approval of the 15 µg/m^3 SIP Revision, including the precursor demonstration for ammonia, on July 14, 2023.[13] The information in this section of the Precursor Demonstration builds on the analysis and conclusions presented in the Ammonia Supplemental Information for the 15 µg/m^3 SIP Revision, relevant here to the 12 µg/m^3 annual PM2.5 standard.

It is important to note that not all control measure concepts are appropriate to be submitted into the SIP as rules. Any rules that are submitted into the SIP must meet U.S. EPA requirements, and must:

- Include enforceable emission limitations and other control measures, means, or techniques, as well as schedules and timetables for compliance, as may be necessary to meet the requirements of the Clean Air Act [Act section 110(a)(2)(A)];
- Provide necessary assurances that the State will have adequate personnel, funding, and authority under State law to carry out such SIP (and is not prohibited by any provision of federal or state law from carrying out such SIP) [Act section 110(a)(2)(E)];
- Be adopted by a State after reasonable notice and public hearing [Act section 110(l)]; and
- Not interfere with any applicable requirement concerning attainment and reasonable further progress, or any other applicable requirement of the Act [Act section 110(l)].

The supplemental evaluation of potential controls on ammonia sources identified by U.S. EPA is found below.

4.3.2.3.1 Evaluation of Potential Controls on Ammonia Emissions Sources

The District and CARB analyzed potential control measures to reduce ammonia emissions in order to evaluate whether a 30 percent reduction in ammonia emissions is feasible. For an effective control measure evaluation, it is necessary to characterize and understand the key sources of ammonia in the Valley.

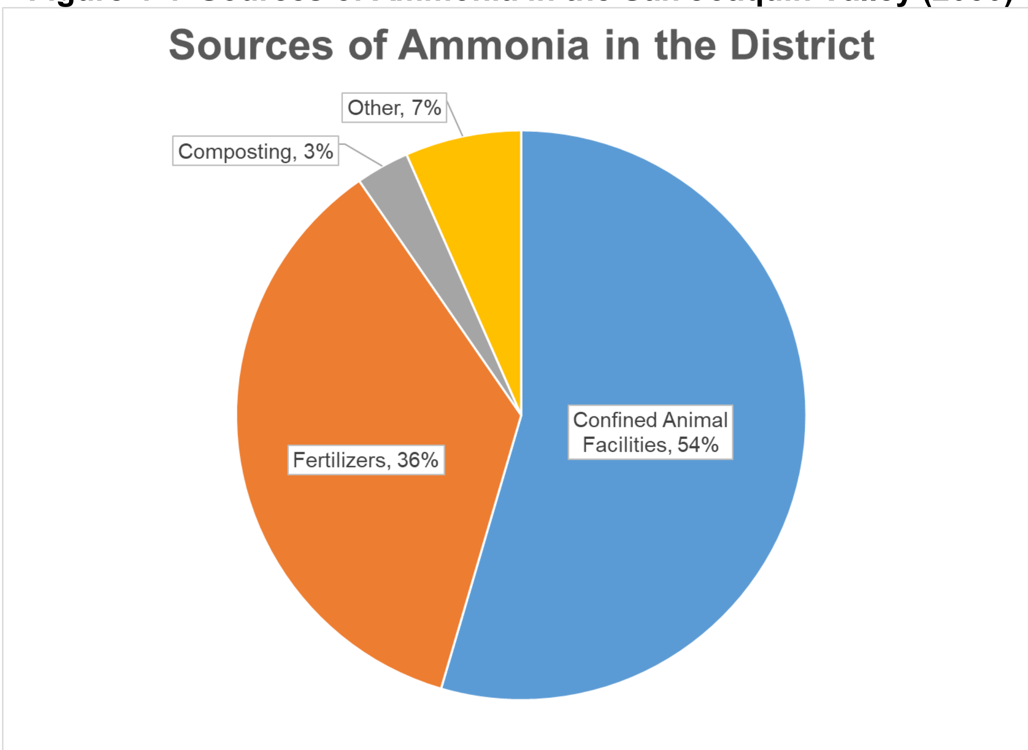
The three main sources of ammonia emissions in the Valley from stationary and area sources, which account for 93 percent of the Valley's ammonia emissions[14], are the focus of the evaluation. Since the attainment year for this SIP is 2030, data and figures below reflect the projected ammonia inventory for that year. The increased level of

[12] CARB. Ammonia: Supplemental Information for EPA in Support of 15 µg/m3 Annual PM2.5 Standard. March 2023. https://ww2.arb.ca.gov/sites/default/files/2023-04/AmmoniaSupplementalInformation.pdf
[13] See 88 FR 45276. (July 14, 2023). Retrieved from: https://www.govinfo.gov/content/pkg/FR-2023-07-14/pdf/2023-14687.pdf
[14] Based on CEPAM 2022 v 1.00 Annual Average Emissions Inventory for 2030

control due to the implementation of District rules and regulations is already incorporated into the projected emission inventory.

- Confined Animal Facilities (CAFs) with 167.2 tons per day (tpd);
- Agricultural Fertilizers at 109.9 tpd; and
- Composting Solid Waste Operations at 9.3 tpd.

Figure 4-4 Sources of Ammonia in the San Joaquin Valley (2030)



Since the primary source of ammonia emissions in the Valley are from CAFs, the District focused its evaluation on the different types of animal operations, specifically dairies, which account for the majority of ammonia emissions.

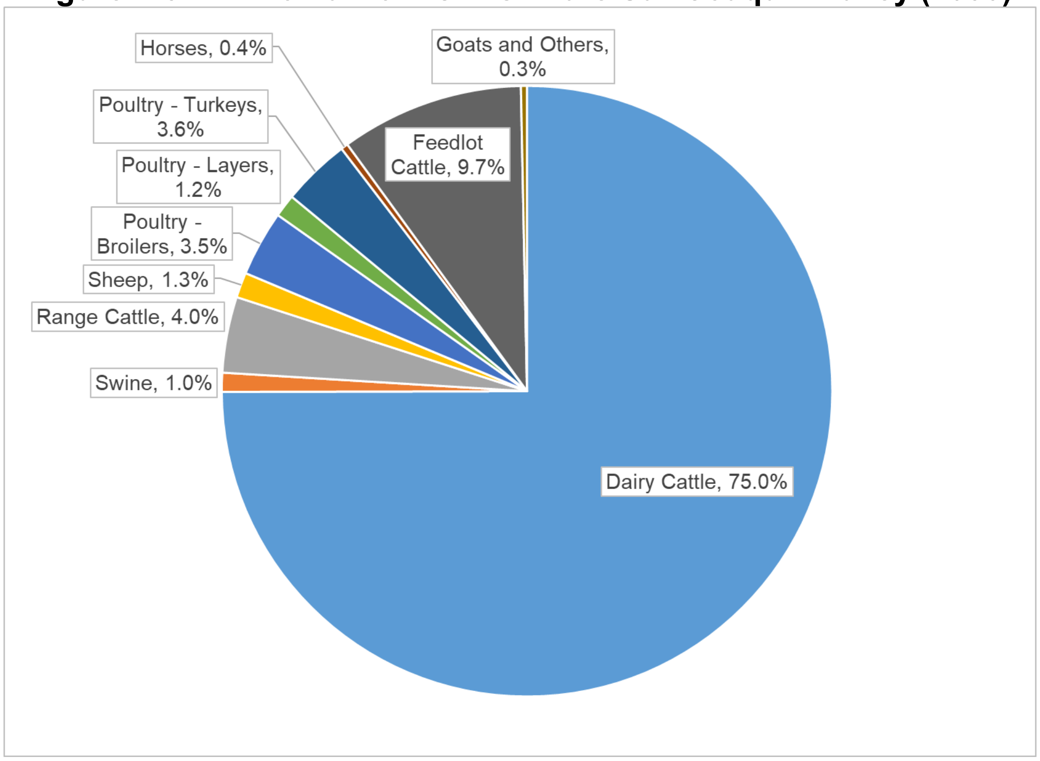
The total ammonia emissions in the Valley in 2030 are 306.5 tons per day. As shown in Table 4-6 below, to reduce the total ammonia emissions by 30 percent, 50 percent, and 70 percent, emissions from CAFs would need to be further reduced by 55 percent, 92 percent, and 128 percent respectively. As shown in the evaluation below, the District has only identified a few measures that have the theoretical potential to reduce additional ammonia emissions, which may achieve a total of up to 2 percent reduction in emissions notwithstanding technological and economic feasibility considerations. These reductions are not capable of achieving the lower bound level of 30 percent reductions, and the 50 percent and 70 percent reduction levels are infeasible.

Table 4-6 CAF Emission Reduction Analysis

	30% Reduction	50% Reduction	70% Reduction
Theoretical Ammonia Reductions (tpd)	91.9	153.2	214.5
% reduction required from CAFs	55%	92%	128%

As shown below in Figure 4-5, dairy cattle emissions account for 75.0 percent of ammonia emissions from CAFs.

Figure 4-5 Ammonia from CAFs in the San Joaquin Valley (2030)



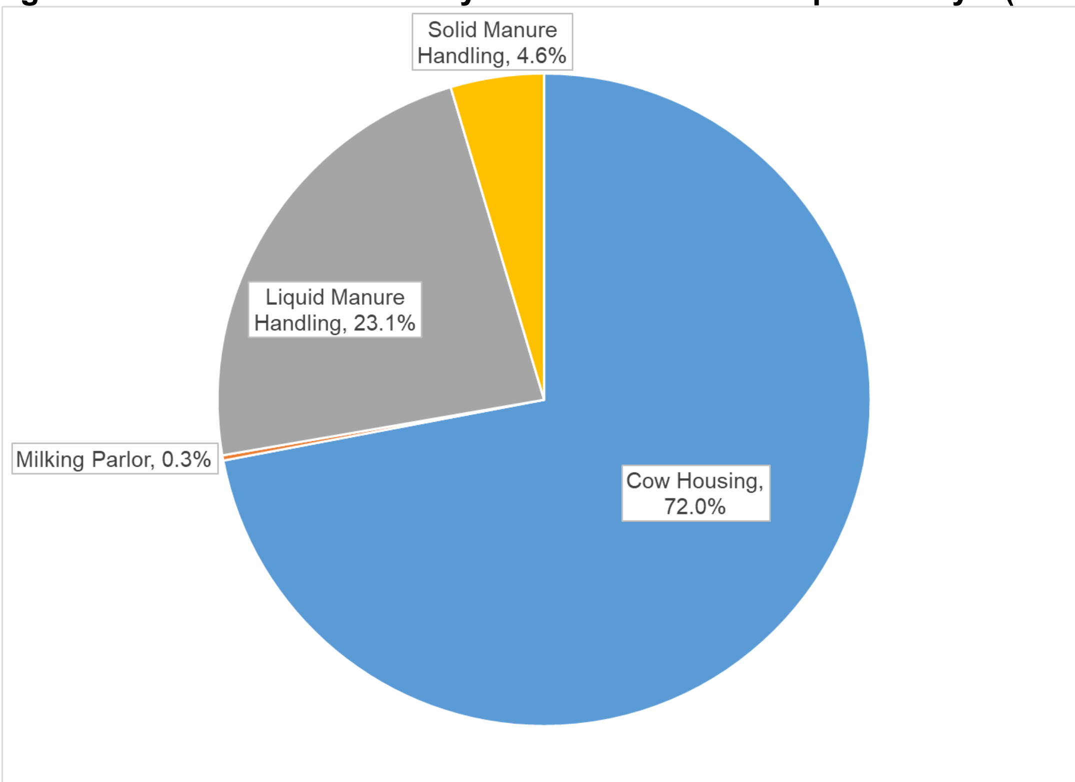
The total ammonia emissions in the Valley in 2030 are 306.5 tons per day. As shown in Table 4-7 below, to reduce the total ammonia emissions by 30 percent, 50 percent, and 70 percent, emissions from dairy cattle would need to be reduced by 73 percent, 122 percent, and 171 percent, respectively.

Table 4-7 Dairy Cattle Emission Reductions Analysis

	30% Reduction	50% Reduction	70% Reduction
Theoretical Ammonia Reductions (tpd)	91.95	153.24	214.54
% reduction required of dairy cattle	73%	122%	171%

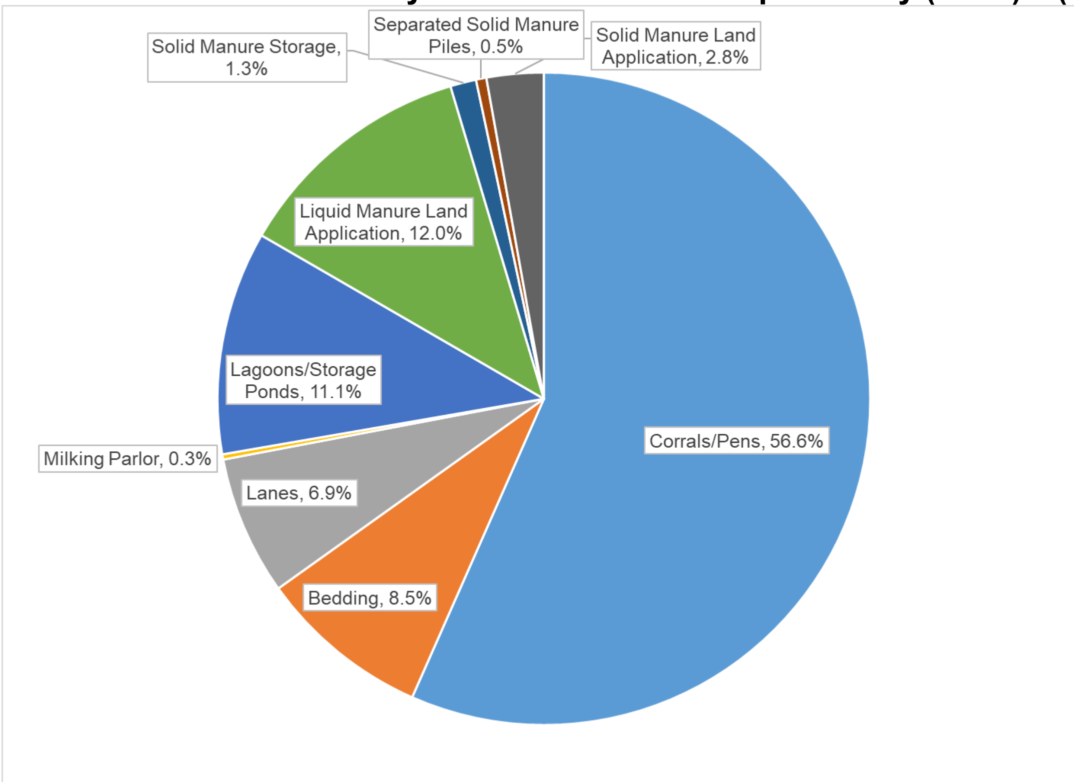
As shown in Figure 4-6, the primary source of ammonia emissions from dairy cattle is cow housing (72 percent). Figure 4-7 further evaluates ammonia emissions from dairy cattle by illustrating the different categories such as corrals/pens (56.6 percent), liquid manure land application (12 percent), and lagoons/storage ponds (11.1 percent), etc. Accordingly, the District has provided an evaluation of mitigation measures for dairy cattle focusing on housing, land application techniques, and solid and liquid manure handling.

Figure 4-6 Ammonia from Dairy Cattle in the San Joaquin Valley[15] (2030)



[15] Based on District ammonia emission factors for dairy cattle.

Figure 4-7 Ammonia from Dairy Cattle in the San Joaquin Valley (cont.)[16] (2030)



Based on the emission inventory analysis above, reducing ammonia emissions by the lower bound precursor demonstration threshold of 30 percent would require eliminating over 50 percent of ammonia emissions from CAFs, or over 70 percent of emissions from only dairy cattle, beyond the ammonia emission reductions already achieved by the requirements of District Rule 4570 (Confined Animal Facilities). A 70 percent reduction of ammonia emissions in the District would require the elimination of all CAFs in the District in addition to other categories that have already achieved significant ammonia reductions.

4.3.2.3.2 Inventory of Confined Animal Facilities in the Valley

The District reviewed current permitted facilities in the Valley. Demonstrated below in Table 4-8 is the count of permitted facilities by type that are subject to Rule 4570, and the controlled ammonia emissions from each type of facility.

[16] Ibid.

Table 4-8 Inventory of Confined Animal Facilities in the Valley (2030)

Facility Type	# of Facilities Subject to Rule 4570[17]	Ammonia Emissions from Facility Type (tpd)
Dairies	859	125.3
Beef Feedlots	6	16.2
Other Cattle	17	6.7
Chicken – Broilers	47	5.8
Chicken – Layers	12	2.0
Turkeys	19	6.0
Swine	1	1.7

4.3.2.3.3 District Rule 4570 (Confined Animal Facilities)

Background

The largest source of ammonia in the Valley is CAFs. The District has implemented Rule 4570 to reduce emissions from this source category, and requires the most stringent requirements for reducing emissions from CAFs in the nation. Rule 4570 was originally adopted on June 15, 2006, and was again amended on October 21, 2010. District Rule 4570 applies to facilities where animals are corralled, penned, or otherwise caused to remain in restricted areas and primarily fed by a means other than grazing for at least 45 days in any twelve-month period. In addition to limiting volatile organic compound (VOC) emissions, District Rule 4570 includes measures that limit ammonia emissions from these operations.

Evaluation of District Rule 4570

District Rule 4570 includes multiple mitigation measures that control ammonia emissions from CAFs. Since these facilities generally cover a large area and have different processes, a single mitigation measure or technology is generally not sufficient to control overall emissions from the facility. Due to the varying types of operations and emissions sources at these facilities, each CAF requires a site-specific constellation of measures to achieve overall emission reductions.

District Rule 4570 includes a large number of measures that must be implemented by each CAF and also requires additional measures to be selected from a menu of mitigation measures options to achieve additional emission reductions. The menu approach gives the facilities the flexibility to achieve the required emission reductions by selecting mitigation measures that are most practical and effective for their operation. As discussed in the District staff report for the 2010 amendments to District Rule 4570,[18] the design and operation of each CAF differs depending on animal type, regional climatic conditions, business practices, and the preferences of the owners/operators. Because of this, no two CAFs are identical. In addition to air quality

[17] Review of District permits database (May 2023)
[18] SJVAPCD. *Staff Report for 2010 Amendments Rule 4570 (Confined Animal Facilities).* Available at: http://valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2010/October/Agenda_Item_7_Oct_21_2010.pdf

regulations, CAFs are subject to other regulations to protect water quality and the environment. These additional regulations often restrict how CAFs can operate.

It is not feasible for all CAFs to implement the same measures due to various factors, such as infrastructure, conditional use permits, water quality regulations, production contracts, and other limitations. The options included in District Rule 4570 provide the owners and operators of CAFs much-needed flexibility to choose the mitigation measures that make the best environmental and economic sense for their facility, while maximizing the amount of emission reductions.

4.3.2.3.4 Other Air District Rules

The District provided an in-depth review of Rule 4570 in Appendix C of the *2018 Plan for the 1997, 2006, and 2012 PM2.5 Standards* (*2018 PM2.5 Plan*), [19] including a comprehensive analysis of Rule 4570, in which the District compared emissions limits, optional control requirements, and work practices in Rule 4570 to comparable requirements in rules from the following areas:

- South Coast Air Quality Management District (SCAQMD) Rule 223 (Emission Reduction Permits for Large Confined Animal Facilities);
- SCAQMD Rule 1127 (Emission Reductions from Livestock Waste);
- Bay Area Air Quality Management District (BAAQMD) Regulation 2, Rule 10 (Large Confined Animal Facilities);
- Ventura County Air Pollution Control District (VCAPCD) Rule 23 (Exemptions from Permit);
- Sacramento Metropolitan Air Quality Management District (SMAQMD) Rule 496 (Large Confined Animal Facilities);
- Imperial County Air Pollution Control District (ICAPCD) Rule 217 (Large Confined Animal Facilities Permits Required) and Policy Number 38 (Recommended Mitigation Measures for Large Confined Animal Facilities); and
- Idaho Administrative Procedure Act 58.01.01 Sections 760-764 (Rules for the Control of Ammonia from Dairy Farms);

In addition to these rules, the District's *2016 Plan for the 2008 8-hour Ozone Standard* (*2016 Ozone Plan*)[20] included a comparison of District Rule 4570 to requirements from the following:

- Butte County Air Pollution Control District (BCAQMD) Rule 450 (Large Confined Animal Facilities); and
- Yakima Regional Clean Air Agency (Air Quality Management Policy and Best Management Practices for Dairy Operations).

[19] SJVAPCD. *2018 Plan for the 1997, 2006, and 2012 PM2.5 Standards*. Appendix C, pages C-311 – C-339. Available at: https://www.valleyair.org/pmplans/documents/2018/pm-plan-adopted/2018-Plan-for-the-1997-2006-and-2012-PM2.5-Standards.pdf

[20] SJVAPCD. *2016 Plan for the 2008 8-hour Ozone Standard*. Available at: http://valleyair.org/Air_Quality_Plans/Ozone-Plan-2016/Adopted-Plan.pdf

Through the rule comparisons included in the *2022 Ozone Plan*, *2018 PM2.5 Plan*, and the *2016 Ozone Plan*, the District demonstrated that Rule 4570 was more stringent than the above rules in other areas, at the time of each plan's adoption. The areas mentioned above have not changed or amended their respective rules since the District's previous evaluations, except for the Yakima Regional Clean Air Agency, which rescinded their policy for dairies in 2018. The District has found no new requirements in other areas, but has reevaluated the rules above and found that Rule 4570 continues to implement the most stringent requirements for CAFs.

4.3.2.3.5 Federal Actions and Guidance

The evaluation of appropriate practices and measures to reduce emissions from confined animal facilities requires accurate methodologies to estimate emissions. The National Academy of Sciences identified the lack of methodologies to estimate emissions from animal feeding operations (AFOs) in 2002. In response, U.S. EPA announced an opportunity for AFOs to sign a voluntary consent agreement and final order known as the Air Compliance Agreement (2005).[21] The goal of the agreement was to develop scientifically credible methodologies for estimating emission models produced by AFOs. AFOs that chose to participate in the agreement provided the funding for the National Air Emissions Monitoring Study (NAEMS). As part of the agreement, U.S. EPA agreed not to sue participating AFOs for certain violations of the Act, Compensation, and Liability Act (CERCLA), and Emergency Planning and Community Right-to-Know Act (EPCRA), provided that the AFOs comply with the agreement's conditions.

The NAEMS monitored 25 AFOs in various regions of the country to have equipment installed for ammonia, hydrogen sulfide, particulate matter, and VOC emissions monitoring. Separate draft models of swine, poultry, and dairy AFOs emissions were created using the monitoring data and input from the U.S. EPA Science Advisory Board.[22]

While data collection took place from 2007 to 2010, these draft models only became publicly available in August 2020, August 2021, and June 2022 for swine, poultry, and dairy AFOs respectively. U.S. EPA's final models to estimate emissions from AFOs are not yet available. Currently, U.S. EPA projects that finalization of all draft models will occur in late 2023.[23] Though U.S. EPA has not provided final guidance on emission estimation methodologies for CAFs, the District has reviewed information from U.S. EPA and many other sources in order to use the best information available to calculate emissions from CAFs.

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[21] See 70 FR 4958. (January 31, 2005). Retrieved from: https://www.epa.gov/sites/default/files/2016-06/documents/afolagooneemreport2012draftappe.pdf

[22] Livestock and Poultry Environmental Learning Community. *NAEMS: How It Was Done and Lessons Learned*. April 20, 2022. Retrieved from: https://lpelc.org/naems/

[23] EPA. *National Air Emissions Monitoring Study*. Retrieved from: https://www.epa.gov/afos-air/national-air-emissions-monitoring-study#naems-status

4.3.2.3.6 District Efforts

The District first began permitting agricultural sources in 2004, and since that time District staff members have gained a great deal of experience in the evaluation of emissions from agricultural sources through collaborative efforts with other institutions, agencies, and interested stakeholders. The District has also been thoroughly involved in collaborative scientific research efforts to evaluate emissions from agricultural sources. This is particularly true of the agricultural emissions research efforts in California. The District has played an important role in coordination of these efforts through the San Joaquin Valleywide Air Pollution Study Agency (Study Agency) and the Study Agency's Agricultural Air Quality Research Committee (AgTech). The District has also been at the forefront of developing and implementing regulations to reduce emissions from CAFs.

The District will continue to track the development of rules, regulations, research/studies, and practices for CAFs to ensure the best available control measures and most stringent measures are in place in the Valley, in coordination with industry stakeholders, researchers, CARB, and other agencies.

4.3.2.3.7 Evaluation of Mitigation Measures for Confined Animal Facilities

In the Federal Register posting for the proposed partial approval and partial disapproval of portions of the state implementation plan revisions for the 1997 annual PM2.5 standard,[24] U.S. EPA indicates that further evaluation of potential control measures for ammonia sources is needed. In U.S. EPA's proposed disapproval of portions of the *2018 PM2.5 Plan* for the 2012 annual PM2.5 standard,[25] U.S. EPA refers to several studies that were cited in a Public Justice comment letter[26] that evaluate CAF mitigation measures that have the potential to achieve additional ammonia reductions. In the same proposal, U.S.EPA noted that the United States Department of Agriculture (USDA) National Resources Conservation Service (NRCS) has collaborated to develop a "Reference Guide for Poultry and Livestock Production Systems" (NRCS Reference Guide) [27] that lists 12 measures that may reduce ammonia emissions by more than 30 percent. U.S. EPA also cited a 2011 inventory of mitigation methods by Price et al. prepared for the UK government (UK User Guide) that identifies several ammonia mitigation methods for UK farms.[28]

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[24] See 86 FR 38662. (July 22, 2021). Retrieved from: https://www.govinfo.gov/content/pkg/FR-2021-07-22/pdf/2021-15551.pdf

[25] See 87 FR 60494. (October 5, 2022). Retrieved from: https://www.govinfo.gov/content/pkg/FR-2022-10-05/pdf/2022-21492.pdf

[26] Public Justice, et al. (January 28, 2022). Group Comment Letter *Re: Clean Air Plans; 2012 Fine Particulate Matter Serious Nonattainment Area Requirements; San Joaquin Valley, California*; EPA-R09-OAR-2021-0884. Retrieved from: https://www.regulations.gov/comment/EPA-R09-OAR-2021-0884-0136

[27] EPA-USDA NRCS. "Reference Guide for Poultry and Livestock Production Systems." September 2017. Retrieved from: https://www.epa.gov/sites/default/files/2017-01/documents/web_placeholder.pdf

[28] Price et al., "An Inventory of Mitigation Methods and Guide to their Effects on Diffuse Water Pollution, Greenhouse Gas Emissions and Ammonia Emissions from Agriculture, User Guide," December 2011. Retrieved from: https://repository.rothamsted.ac.uk/download/942687eab7ec4b83751c7e241d62f0fa8472d72adcd25a149bb891b7c30d55d0/1595300/MitigationMethods-UserGuideDecember2011FINAL.pdf

Following the proposed disapprovals and several meetings with U.S. EPA Region 9 staff, the District was provided with a list of mitigation measures generated by EPA Region 9 staff for evaluation, many of which the District has already evaluated over the years. As discussed earlier, it is also important to note that U.S. EPA has been committed to addressing emission from livestock operations under a voluntary "safe harbor" consent agreement put into place by U.S. EPA in 2005. While the San Joaquin Valley has regulated emissions from livestock operations since 2005, U.S. EPA is still in the process of evaluating emissions and establishing the regulatory framework under this consent agreement, and the District will continue supporting the national effort to address emissions from these operations. This list encompassed publications that evaluated potential ammonia emission reductions for either individual mitigation measures or compilations of mitigation measures. The publications provided to the District included a wide variety of mitigation measures such as reducing crude protein content in feed, litter amendments, injection/incorporation of manure, changing land use from arable to woodland, and reducing human consumption of meat and eggs.

Though some of the suggested measures have related studies that appear to demonstrate potential feasibility, it is imperative to consider the conditions under which the studies were performed and how those conditions compare to the Valley. Several of the studies evaluated were conducted in areas outside of California, and many outside of the nation. Notably, CAFs in the Valley face unique challenges, including hot, dry summers, drought conditions, and strict water regulations, which may not have been considered in some of the publications and studies that evaluated these methods. Valley dairies in particular are typically much larger than dairies in other areas. Based on information from the USDA National Agricultural Statistics Service, the average dairy in the Valley has almost 1,600 cows compared to a national average of less than 300 cows per dairy outside of California.[29, 30] The UK User Guide, which contains many of the measures evaluated in this document, indicated that the average UK dairy has 170 cows. The differences in climate, typical management practices, size of operations, and regulatory environment affect the types of mitigation measures that can be applied to each operation.

Many of the mitigation measures for consideration by U.S. EPA were not applicable to the Valley, were unreasonable or unenforceable, or were based on limited applicability in California (e.g., research conducted in other countries with drastically different operating and natural characteristics). The complete list of potential mitigation measures provided by U.S. EPA Region 9 staff can be found in Appendix A of the Ammonia Supplemental Information for the 15 μg/m^3 SIP Revision.[31] The District's evaluation of all potential mitigation measures provided by U.S. EPA is included in the following sections.

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[29] Hanson, M. (2021) U.S. Dairy Herd Hits 27-year High. *Dairy Herd Management.* Retrieved from: https://www.dairyherd.com/news/dairy-production/us-dairy-herd-hits-27-year-high

[30] Latest USDA Statistics for average size of dairies excluding California, retrieved from: https://downloads.usda.library.cornell.edu/usda-esmis/files/h989r321c/7d279w693/f7624g40c/mkpr0222.pdf (about 270 cows per dairy outside California)

[31] CARB. Ammonia: Supplemental Information for EPA in Support of 15 μg/m3 Annual PM2.5 Standard. March 2023. https://ww2.arb.ca.gov/sites/default/files/2023-04/AmmoniaSupplementalInformation.pdf

Nutrition and Feed Management (Feeding)

Table 4-9 Nutrition and Feed Management Measures Evaluated

Method	Measure	CAF Type	Reference
Reducing Crude Protein (Beef)	Influence of Dietary Crude Protein Concentration and Source on Potential Ammonia Emissions from Beef Cattle Manure	Beef	Preece[32]
	Reducing Crude Protein in Beef Cattle Diet Reduces Ammonia Emissions from Artificial Feedyard Surfaces	Beef	Todd[33]
	Reduce Dietary Crude Protein in Beef Cattle	Beef	Cole (2005)[34]
Reducing Crude Protein (Dairy)	Reducing Dietary Protein Decreased the Ammonia Emitting Potential of Manure from Commercial Dairy Farms	Dairy	Hristov[35]
Reducing Crude Protein (Swine)	Reduce Crude Protein Content from Finishing Pig Houses	Swine	Hayes[36]
Feed Timing	Phase, Group, and Split Sex-Feeding	Beef	Cole (2006)[37]
	Group and Phase Feeding	All	NRCS[38]
	Phase Feeding	All	Guthrie[39]

[32] Preece, Sharon L.M. et al., ‘‘Ammonia Emissions from Cattle Feeding Operations,’’ Texas A&M AgriLife Extension Service, referring to Cole, N.A., R.N. Clark, R.W. Todd, C.R. Richardson, A. Gueye, L.W. Greene, and K. McBride, ‘‘Influence of Dietary Crude Protein Concentration and Source on Potential Ammonia Emissions from Beef Cattle Manure,’’ Journal of Animal Science 83:(3), 722 (2005)
[33] Todd, R.W., N.A. Cole, and R.N. Clark, ‘‘Reducing Crude Protein in Beef Cattle Diet Reduces Ammonia Emissions from Artificial Feedyard Surfaces.’’ Journal of Environmental Quality. 35:(2), 404–411 (2006).
[34] Cole, N., et al., Influence of dietary crude protein concentration and source on potential ammonia emissions from beef cattle manure. J. Anim. Sci. 83, 722 (2005).
[35] Hristov, A. N., Heyler, K., Schurman, E., Griswold, K., Topper, P., Hile, M., ... & Dinh, S. (2015). CASE STUDY: Reducing dietary protein decreased the ammonia emitting potential of manure from commercial dairy farms. The Professional Animal Scientist, 31(1), 68-79
[36] Hayes ET, Leek AB, Curran TP, et al. The influence of diet crude protein level on odour and ammonia emissions from finishing pig houses. Bioresource Technology, 2004
[37] Cole NA, Defoor PJ, Galyean ML, Duff GC, Gleghorn JF. “Effects of phase-feeding of crude protein on performance, carcass characteristics, serum urea nitrogen concentrations, and manure nitrogen of finishing beef steers”, Journal of Animal Science, 2006
[38] EPA-USDA NRCS. “Reference Guide for Poultry and Livestock Production Systems.” September 2017. Retrieved from: https://www.epa.gov/sites/default/files/2017-01/documents/web_placeholder.pdf
[39] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). The Impact of Ammonia Emissions from Agriculture on Biodiversity. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html

Method	Measure	CAF Type	Reference
Wet Distillers Grain	Reduce Feeding of Wet Distillers Grain	Beef	Todd[40]
Grazing	Increase Grazing Time for Dairy Cattle	Dairy	Guthrie
Feed Additives	Feed Additives for Poultry	Poultry	NRCS

Reducing Crude Protein Content for Beef Cattle - ***(applies to beef cattle only)***

U.S. EPA noted that studies in 2005 and 2006 found that "*decreasing the crude protein concentration of beef cattle finishing diets based upon steam-flaked corn from 13 to 11.5 percent decreased ammonia emissions by 30 to 44 percent.*"

In the 2005 study, steers were randomly assigned to one of nine dietary treatments (three formulated dietary crude protein (CP) concentrations and three supplemental urea: cottonseed meal ratios). Steers were confined to tie stalls, and feces and urine excreted were collected and frozen after approximately 30, 75, and 120 days on feed. As protein concentration in diet increased from 11.5 to 13 percent, in vitro daily ammonia emissions increased 60 to 200 percent, due primarily to increased urinary nitrogen excretion. As days on feed increased, in vitro ammonia emissions also increased.

This study had a small sample size with 54 cattle used for nine dietary treatments (six cattle per treatment). These results are only applicable to the finishing cycle of beef cattle lives (four to six months of age), and not applicable to milk cows and support stock at dairies. There are very few finishing cycle feeder beef cattle in the Valley. Most beef cattle in California are beef calves and stockers, fed through grazing. Most of these cattle are sent outside of California for the finishing cycle.[41, 42]

Notably, beef finishing cattle make up a small part of the overall inventory of cattle in the Valley. The current feedlot cattle inventory includes all feedlot cattle; however, the lives of beef cattle are divided into different phases of production. Cow and calf pairs are raised on rangeland. Weaned yearlings/stockers may continue to be raised on rangeland or be sent to yearling/stocker feedlots until a weight of approximately 800 to 900 pounds. Finally, beef cattle are sent to other feedlots out of California for the finishing phase, in which the cattle are fed for four to six months until they reach the desired finished weight. Because of the higher cost of feeding cattle in California and

[40] Todd, R.W., N.A. Cole, D.B. Parker, M. Rhoades, and K. Casey. 2009. "Effect of Feeding Distillers Grains on Dietary Crude Protein and Ammonia Emissions from Beef Cattle Feedyards." In Proceedings of the Texas Animal Manure Management Issues Conference, 83–90.
[41] Andersen, M.A., Blank, S.C., LaMendola, T, Sexton, R.J., "California's Cattle and Beef Industry at the Crossroads", California Agriculture 56(5),152-156. Retrieved from: https://doi.org/10.3733/ca.v056n05p152
[42] Saitone, T.L., "Livestock and Rangeland in California", Livestock and Rangeland in California. Retrieved from: https://s.giannini.ucop.edu/uploads/giannini_public/94/c1/94c100fd-9626-47d4-8b82-0bfdb1081a57/livestock_and_rangeland.pdf

the lack of sufficient beef processing capacity, most of feedlot cattle in California are yearlings/stockers for which this measure does not apply.[43]

If dietary protein concentrations are decreased to the point that animal performance is adversely affected, then total ammonia emissions could be increased because animals require more days on feed to reach market weight and condition. There was also little change in ammonia between the 13 percent and 14.5 percent CP groups.

In the 2006 study, two groups of steers were fed diets with either 11.5 or 13 percent CP and all urine and feces were collected. Manure from steers fed 11.5 percent CP diet had less urine, less urinary nitrogen, and a lesser fraction of total nitrogen in urine, compared with the 13 percent crude protein diet. Decreasing CP in beef cattle diets from 13 to 11.5 percent significantly decreased ammonia emission by 44 percent in closed chamber experiment, and decreased mean daily ammonia flux by 29 percent, 30 percent, and 52 percent in spring, summer, and autumn field trials, respectively. No difference was observed in winter.

Additionally, National Research Council (NRC) Nutrient Requirements of Beef Cattle states that decreasing the CP concentration in the diet can potentially reduce animal performance, prolonging the time necessary to reach market weight and potentially increasing ammonia emissions over the life of the cattle. Because adequate protein levels are required for optimal growth, decreasing CP levels hinder the ability to meet daily weight gain goals.

The overall effectiveness of this measure is unclear because of the small sample size and short period of the study. NRC Nutrient Requirements of Beef cattle states that decreasing the CP concentration in the diet can potentially reduce animal performance. Higher CP levels may be needed to meet daily weight gain goals.

If decreasing the CP content of the diet adversely affects performance, any short-term ammonia reductions can be negated by the longer time on feed required for animals to reach their target market weight and condition.[44] While there may be ammonia reductions in the short term, longer time on feed will result in additional ammonia emissions for the additional amount of time it takes for the animals to reach the appropriate weight. Thus, overall emissions may ultimately be the same, or possibly even increase. Due to the limited pool of data and only studying emissions for 21 days, more research is needed to show a full-cycle of emissions and full impact to the animals.

[43] Forero, L., Barry, S., Larson, S. (2021). Beef Cattle on California Annual Grasslands: Production Cycle and Economics. *University of California Agriculture and Natural Resources*. Retrieved from: https://anrcatalog.ucanr.edu/pdf/8687.pdf

[44] Cole NA, Defoor PJ, Galyean ML, Duff GC, Gleghorn JF. “Effects of phase-feeding of crude protein on performance, carcass characteristics, serum urea nitrogen concentrations, and manure nitrogen of finishing beef steers”, Journal of Animal Science, 2006.

Despite the uncertainties discussed above, the District further evaluated the potential emission reductions of implementing this measure in the Valley. This analysis is provided below.

The feedlot cattle inventory in the Valley includes calves, beef stockers, yearlings, and finishing cattle. This measure is only applicable to beef finishing cattle. It will be conservatively assumed that 50 percent of the feedlot cattle in the Valley are beef finishing cattle. The ammonia emissions from young beef cattle compared to beef finishing cattle will be assumed to be proportional to their nitrogen excretion. Based on information from the American Society of Agricultural and Biological Engineers (ASABE),[45] it is estimated that the average daily nitrogen excretion for beef finishing cattle is 25.7 percent higher than young beef cattle. Therefore, the overall control efficiency for this measure can be estimated as follows:

30% x 50% x 1.257 = 18.9%

No costs for implementation of this measure in the United States could be located. Notably, feed costs are a significant part of the overall costs of raising livestock, often representing as much as 60-70 percent of production costs,[46] and protein is often the most expensive component in livestock feed.[47] As a result, beef cattle producers will generally avoid overfeeding protein to minimize productions costs. Therefore, the actual emission reductions from this measure may be significantly lower to nothing since most beef cattle producers will already try to minimize feeding excess protein whenever feasible.

The District has concluded that the measure requires further research on both the effect on production and overall costs, and therefore is not a viable mitigation option to include in Rule 4570 at this time. The District will continue to evaluate the feasibility of this option as practices evolve and further research is conducted.

Reducing Crude Protein Content for Dairy Cattle - ***(applies to dairy cattle only)***

In a compilation by Bittman[48] it was recommended that the average CP content of diets for dairy cattle should not exceed 15-16 percent of the dry matter (DM). Phase feeding can be applied in such a way that the CP content of dairy diets is gradually decreased from 16 percent of DM just before calving and in early lactation to below 14 percent in late lactation and the main part of the dry period.

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[45] American Society of Agricultural and Biological Engineers. (March 2005). ASABE D384.2 Manure Production and Characteristics. Retrieved from: https://elibrary.asabe.org/abstract.asp?aid=32018
[46] Strauch, B.A., Stockton, M.C. (Sep 2013). Feed Cost Cow-Q-Lator. NebGuide. University of Nebraska–Lincoln Extension, Institute of Agriculture and Natural Resources (G2214). Retrieved from: https://extensionpublications.unl.edu/assets/pdf/g2214.pdf
[47] North Dakota State University (NDSU). (Dec 2019). Comparing Value of Feedstuffs (AS1742). Retrieved from: https://www.ag.ndsu.edu/publications/livestock/comparing-value-of-feedstuffs
[48] Bittman, S., Dedina, M., Howard C.M., Oenema, O., Sutton, M.A., (eds). (2014). “Options for Ammonia Mitigation: Guidance from the UNECE Task Force on Reactive Nitrogen,” Centre for Ecology and Hydrology, Edinburgh, UK. Retrieved from: http://www.vuzt.cz/svt/vuzt/publ/P2014/037.pdf

A study[49] measured the effect of reducing the CP content of ammonia emitting potential of dairy manure in a controlled environment. Eleven Pennsylvania dairies with gutter-scrape, gravity-flow, or flush manure-management systems participated in the study. In the study, the CP concentration of the feed for cows that were identified as high-producing cows was decreased from an average of 16.5 to 15.4 percent for the dairies included in the study. Fecal and urine samples were collected from the dairies in the fall of 2009, spring of 2010, fall of 2010, and spring of 2011. The study indicated that laboratory ammonia emissions from reconstituted manure was on average 23 percent lower for the low CP diet versus the high CP diet. No difference was seen in milk yield and milk composition during the low CP and the high CP diet, with average milk yields of 32.2 kg/day and 32.5 kg/day. The researchers that conducted the study concluded that the ammonia emitting potential of dairy manure can be reduced by moderately decreasing dietary CP content.

Although effects of reducing the CP content of the feed for dairy cows may merit further research, there are questions related to the applicability of this study to dairy cattle in the Valley. One important question is if the milk production of the cows in the study is comparable to the milk production of cows in the Valley. The average milk production of the high-producing cows included in the study was only 32.2-32.5 kg/day. In comparison, according to information from USDA National Agricultural Statistics Service, on average, milk cows in California produced approximately 36.2 kg/day of milk in 2021, [50] with high-producing cows in the Valley producing at a rate of 44 to over 50 kg/day of milk per dairy cow.[51] Therefore, although the cows in the study were identified as high-producing cows that were expected to produce greater amounts of milk, the average milk cow in California produces more milk than the cows in this study. Higher levels of milk production require higher levels of protein, so it is likely that reducing the CP content of feed will reduce milk yields of cows that produce milk.

In communications with the District, Dr. Peter Robinson, UC Davis Extension Specialist, Dairy Cattle Nutritional Management Department of Animal Science, stated that the optimal CP level for high-producing dairy cows in the Valley is around 16.8 percent, which is the level that dairy typically feed their high-producing cows. He also states that when CP levels are decreased to levels that are a little lower than required, milk production tends to be negatively impacted immediately. Dr. Robinson’s recommended CP content is based on 14 large on-farm studies that he has completed in the Valley from 2005 to the present. [52] Based on the data he provided from these studies, feed with a CP content of approximately 16.9 percent resulted in maximum milk production for high-producing cows in the Valley, which was about 48.5 kg/day of milk, 50 percent

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[49] Hristov, A. N., Heyler, K., Schurman, E., Griswold, K., Topper, P., Hile, M., ... & Dinh, S. (2015). CASE STUDY: Reducing dietary protein decreased the ammonia emitting potential of manure from commercial dairy farms. The Professional Animal Scientist, 31(1), 68-79

[50] USDA, National Agricultural Statistics Service. Milk Production (February 2022). https://downloads.usda.library.cornell.edu/usda-esmis/files/h989r321c/7d279w693/f7624g40c/mkpr0222.pdf

[51] Data from studies of dairy cows in the San Joaquin Valley provided by Dr. Peter Robinson, UC Davis Extension Specialist, Dairy Cattle Nutritional Management Department of Animal Science. https://animalbiology.ucdavis.edu/people/peter-robinson

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

more than the milk production of the high-producing cows in this study. Therefore, 50 percent more high-producing cows would be needed to produce the same amount of milk, which would negate the ammonia reductions from this measure. Another potential issue with the study is that manure samples of a specific size were used to compare the ammonia emitting potential of the manure, but it is unclear if the changes in feed composition affected manure production, which could also affect ammonia emissions.

As discussed above, California dairy operators typically feed their high-producing cows a diet that has CP content near the optimum level of 16.8 percent, and decreasing the CP content of the diet can have an adverse effect on milk production in dairy cattle. Thus, CP reductions for dairy cattle must be closely managed to avoid impacting productivity (e.g., milk yield, fat corrected yield, milk protein yield). Additionally, Dr. Robinson stated that most cows need to recoup body weight during later lactation and that lowering the CP percentage in the diet during this period could have very negative impacts on both milk yield and body weight recovery.

Because nutrient concentrations in feed and feed ingredients vary considerably, reducing CP in diets will require additional lab analyses of feed to ensure that animals receive sufficient nutrients, which will result in increased costs. Dairy operators have no incentive to overfeed protein since high protein feeds are usually the most expensive ingredients. The percent of CP in the diets fed that California dairy operators feed to dairy cattle has been significantly reduced from previous levels. According to Dr. Robinson, CP in the diets of dairy cows was frequently in excess of 20 percent in the 1980s and 1990s, but that has decreased to the current level of 16.8 percent today. In communication with District staff, Dr. Robert Hagevoort, Extension Dairy Specialist and Topliff Dairy Chair, New Mexico State University, [53] also confirmed similar reductions in the CP content of dairy feed for dairies in the western U.S. compared to previous levels.

In addition, reducing the CP content to the recommended levels is difficult for cattle that graze or are fed a large amount of grass because grass has higher amounts of protein. The NRCS Reference Guide indicates that reduction of CP can also cause deficiency in certain amino acids that can adversely affect animal performance, such as weight gain.

California dairies are expected to continue to try to improve feed efficiency and minimize environmental impacts. However, it is not feasible to require this measure at this time because of questions that remain about the impact on milk production, animal health, and costs on California dairies. Therefore, the District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Reducing Protein Content for Swine - ***(applies to swine only)***

Research indicates that low-protein diets may result in poorer performance in finishing pigs than conventional diets.[54] The NRCS Reference Guide indicates that changes to

[53] https://dairy.nmsu.edu/faculty-staff/robert-hagevoort.html (accessed March 15, 2023)
[54] Hayes ET, Leek AB, Curran TP, et al. The Influence of Diet Crude Protein Level on Odour and Ammonia Emissions from Finishing Pig Houses. Bioresource Technology, 2004

animal diets generally increase costs because of the time and expense of diet formulation and acquisition of new ingredients, and that the availability of additives and feedstuff fluctuates. Additionally, there are increased costs for low-protein feed due to the need to supplement with amino acids found in protein like crystalline lysine, threonine, tryptophan, methionine and valine. As previously shown, emissions from swine are a small part of the District's ammonia inventory, as there is only one permitted swine facility in the District. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Reduce Feeding of Wet Distillers Grain - *(applies to beef cattle only)*

In another study, U.S. EPA noted that "one feedyard feeding distillers grains averaged 149 grams of ammonia-N per head per day (ammonia–N/head/day) over nine months, compared with 82 g ammonia–N/head/day at another feedyard feeding lower protein steamflaked, corn-based diets." Nominally, this would represent a 45 percent reduction in ammonia emissions from manure by going to a lower protein diet. However, the net ammonia emission reduction either from reducing crude protein levels in feed, or by providing a lower protein steam-flaked, corn-based diet rather than a distiller grain diet is unclear given the role of protein intake on the time for beef cattle to reach market weight or on milk production for dairy cows.[55]

This study involved two years of near-continuous ammonia emission data collections at two feedyards. Cattle were fed either conventional feed or wet distillers grains (WDG). Ammonia emissions were 36 percent higher for cattle that were fed WDG.

This study is only applicable to WDG, a feed byproduct of ethanol production. The study notes that WDG typically contains 20 percent or more of protein. That is higher than the ideal diet protein content of 11.5-13.5 percent for beef cattle. This feed is not common in California, because WDG is sold primarily to dairies or cattle feedlots within the immediate vicinity of an ethanol plant, and California only grows 0.07 percent of the nation's corn[56], and produces 0.8 percent[57] of the nation's ethanol. Since dairies in the Valley do not feed WDG, and there is almost no means for WDG feed to be acquired by Valley dairies, this measure is already being implemented and no further emission reductions can be achieved.

Phase, Group, and Split Sex-Feeding - *(applies to all CAFs)*

The NRCS Reference Guide and a compilation by Guthrie, Giles, etc.[58] focus on mitigation measures for feed management including group and phase feeding, dietary

[55] Todd, R.W., N.A. Cole, D.B. Parker, M. Rhoades, and K. Casey. (2009). "Effect of Feeding Distillers Grains on Dietary Crude Protein and Ammonia Emissions from Beef Cattle Feedyards." In Proceedings of the Texas Animal Manure Management Issues Conference, 83–90.
[56] United States Department of Agriculture - National Agricultural Statistics Service, 2017 Census of Agriculture
[57] U.S. Energy Information Administration, State Energy Data 2020: Production
[58] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). The Impact of Ammonia Emissions from Agriculture on Biodiversity. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html

formulation changes, and feed additives. Controlling the protein content of feed is a key element to lowering nitrogen content of manure. Protein naturally contains nitrogen compounds that are often broken down into simple compounds such as ammonia. Group and phase feeding allows the animal to receive the proper nutrition intake by separating animals by age or sex. This allows for a specific diet tailored to each group in order to reduce manure excretion and nitrogen content. Split sex feeding programs are already included as a mitigation option in District Rule 4570 for swine facilities.

The Reference Guide states that dietary formulation changes involve changes in feed ingredients or ration formulations to provide essential available nutrients to meet animal requirements while minimizing excess amounts of nutrients.

Because feed is one of the most significant costs for confined animal facilities, producers work with nutritionists to design diets to maximize feed efficiency and minimize excess nutrients to reduce overall costs. Confined animal facilities work to continually improve feed formulations to deliver nutrients in the amounts required to meet production goals. Overfeeding is undesirable because it will increase costs and farming operations have overall small margins of profit. Operations that overfeed would not be able to compete and would not remain in business because they would not be able to compete with operations that formulate rations for greater efficiency.

As a result of genetic selection and improved diets, milk production per cow has increased and feed usage has decreased by 77 percent.[59] For poultry, it is estimated that genetic selection and the current feed practices have reduced nitrogen excretion by poultry by up to 55 percent.[60]

Rule 4570 includes mitigation options for feeding animals in accordance with NRC Guidelines. The NRC Guidelines establish different nutrition requirements for animals at different ages and stages of production. Nutritionists formulate diets to meet the requirements at these different ages and stages of production.

As stated above, farms already formulate diets to maximize feed efficiency and minimize excess nutrients. There are many challenges to further dietary changes[61], including:

- Nutrient concentrations in feed and feed ingredients vary considerably; therefore, changing feed formulations of diets will require additional lab analyses of feed resulting in increased costs;

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[59] McCabe, C. (2021). How Dairy Milk Has Improved its Environmental and Climate Impact. Clarity and Leadership for Environmental Awareness and Research at UC Davis. Retrieved from: https://clear.ucdavis.edu/explainers/how-dairy-milk-has-improved-its-environmental-and-climate-impact

[60] United States Department of Agriculture - Natural Resources Conservation Service. (2020). Feed and Animal Management for Poultry. Nutrient Management Technical Note No. 190-NM-4. Retrieved from: https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=45569.wba

[61] EPA-USDA NRCS. "Reference Guide for Poultry and Livestock Production Systems", pp. 12-13. September 2017. Retrieved from: https://www.epa.gov/sites/default/files/2017-01/documents/web_placeholder.pdf

- Changes in dietary formulations increase feed costs due to the time and expense of diet formulation and acquisition of new ingredients;
- Reduction of crude protein nitrogen can cause deficiency in certain amino acids, such as lysine, threonine, and methionine, that can adversely affect animal performance, including growth and milk production; and
- Crude protein reductions for dairy cattle must be closely managed to avoid impacting productivity.

As discussed above, confined animal facilities already formulate diets to maximize feed efficiency and minimize excess nutrients to reduce overall costs and remain competitive. Rule 4570 includes mitigation options for feeding animals in accordance with NRC Guidelines, which includes specific nutrient requirements for different animals. Therefore, this measure is already implemented by the confined animal facilities in the Valley and any ammonia reductions from this measure are already being attained.

Phase feeding and split-sex feeding have been commonly used at confined animal facilities throughout the nation for many years, particularly on larger operations,[62, 63, 64, 65] and are a standard practice for the relatively larger confined animal facilities subject to District permitting requirements in the Valley. Because of the higher cost of production in California, confined animal facilities are larger operations compared to other states to take advantage of economies of scale. The standard practice at these operations is to separate animals by phases, ages, or groups that are fed specific diets. At dairies, calves, young heifers, bred heifers, dry cows, milk cows in different stages of lactation, and sick cattle are placed in separate groups and fed rations that are specifically formulated. Beef cattle are separated into cows and calf pairs raised on rangeland, bulls, yearlings/stockers, and finishing cattle, which are fed a separate diet. Broiler chickens are typically fed three to four different diets during their grow-out period and turkeys may be fed up to six diets during their grow-out period to match the specific age or stage of production.[66] It is estimated that genetic selection and the current feed practices have reduced ammonia reduced nitrogen excretion by poultry by up to 55 percent.

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[62] Carter, S., Sutton, A., Stenglein, R. (2012). Diet and Feed Management to Mitigate Airborne Emissions – Air Quality Education In Animal Agriculture. *USDA National Institute of Food and Agriculture.* Retrieved from: https://lpelc.org/wp-content/uploads/2019/03/Dietand-Feed-FINAL.pdf

[63] Van Heutgen, E. (2010) Growing-Finishing Swine Nutrient Recommendations and Feeding Management. Pork Information Gateway Factsheets Number PIG 07-01-09. https://porkgateway.org/resource/growing-finishing-swine-nutrient-recommendations-and-feeding-management/

[64] USDA Animal and Plant Health Inspection Service (APHIS). Iowa State University (2022) US Poultry Industry Manual - Broilers: brooding. Poultry FAD Preparedness & Response Series. https://www.thepoultrysite.com/articles/fad-broilers-brooding

[65] Miles, R.D., Jacob, J.P. (2000) Feeding the Commercial Egg-Type Laying Hen. Florida Cooperative Extension Service, Institute of Food and Agricultural Sciences, University of Florida. https://ucanr.edu/sites/placernevadasmallfarms/files/102990.pdf

[66] Moss A, Chrystal P, Cadogan D, Wilkinson S, Crowley T, Choct M. (2021). "Precision feeding and precision nutrition: a paradigm shift in broiler feed formulation?" *Animal Bioscience*, 2021;34(3):354-362. Retrieved from: https://www.animbiosci.org/journal/view.php?doi=10.5713/ab.21.0034

Phase feeding is the standard practice in the Valley which also allows for reduction in feed costs and meet production goals. In addition, Rule 4570 includes feeding animals in accordance with NRC Guidelines. The NRC Guidelines establish different nutrition requirements for animals at different ages and stages of production. Nutritionists formulate diets to meet the requirements at these different ages and stages of production. Because phase feeding is in practice at the majority if not all of confined animal facilities in the Valley, any ammonia reductions of this practice are currently being achieved. No additional ammonia reductions are expected from the suggested mitigation measure.

Increase Grazing Time for Dairy Cattle - ***(applies to dairy cattle only)***

A compilation by Guthrie[67] states that increased grazing time could reduce ammonia from dairy operations by up to 50 percent as distributed urine can be absorbed into soil and broken down before ammonia is released. However, this practice is not feasible in the Valley, as there is not sufficient land to graze cattle and the arid climate generally requires irrigation to grow crops.

The University of California Agricultural and Natural Resources (UC ANR) publication[68] estimates that the long-term carry capacity of rangeland for grazing in Madera County is 15 or 16 acres per 1,000 lb animal unit; therefore, based on the information in this publication approximately 21-22 acres of unirrigated rangeland would be required to allow a typical 1,400 lb mature dairy cow to graze. The University of California Cooperative Extension (UCCE) publication[69] indicates that 15-18 acres of unirrigated rangeland are required to support a 1,200 lb cow in the Sierra Foothills for one year, and that one acre of irrigated pasture would produce enough forage to feed a 1,200 lb cow for six months. Based on the information in these publications, it is estimated that in the San Joaquin Valley 1522 acres of unirrigated land would be required for each mature cow to graze for a year, one acre of irrigated pasture would be required for a mature cow to graze for six months, and two acres of irrigated pasture would be required for a mature cow to graze for one year. The enormous amount of land required to graze cattle on non-irrigated land clearly makes this infeasible. Based on information from the USDA National Agricultural Statistics Service, the average dairy in the Valley has approximately 1,600 milk and dry cows, not including heifers and calves. Therefore, it is estimated the average dairy in the Valley would require 1,600 acres of land to graze its mature cows for 6 months and 3,200 acres of land to graze its mature cows for one year. Because of the often arid conditions in the Valley, this land would need to be regularly irrigated to sustain sufficient forage for grazing. Additionally, this measure

[67] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). The Impact of Ammonia Emissions from Agriculture on Biodiversity. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html
[68] George, M., Frost, W., and McDougald, N. (December 2020). Ecology and Management of Annual Rangelands Series Part 8: Grazing Management. University of California Agricultural and Natural Resources Publication 8547. https://anrcatalog.ucanr.edu/pdf/8547.pdf
[69] Macon, D., and Meyer, H. (June 2018). How Many Cows Can My Property Support? - Basics of Carrying Capacity, Stocking Rate, and Pasture Irrigation. University of California Cooperative Extension. *UCCE Placer/Nevada Publication 31 1005.* Retrieved from: https://projects.sare.org/wp-content/uploads/Pub-31-1005-Carrying-Capacity-and-Stocking-Rate.pdf

would be impossible to implement as a result of the ongoing severe drought, the Sustainable Groundwater Management Act (SGMA), and limitations on water usage pose severe challenges to the Valley.

The study Survey of Dairy Housing and Manure Management Practices in California[70] reported that in 2007, the average number of milk and dry cows of dairies that responded to the survey in Tulare County was 1,800 cows and that these dairies had 524 acres on which manure was applied to grow feed. Assuming that the acreage for feed production on a dairy in the Valley is proportional to the number of mature cows, the average dairy in Valley with 1,600 mature cows is estimated to have approximately 466 acres of land used for feed production. If half of this land is maintained for feed production and the mature cows at the dairy are grazed on irrigated pasture for six months, the average dairy would require approximately 1,367 additional acres (1,600 acres – 233 acres). For grazing of mature cows on irrigated pasture for the entire year, the average dairy in the Valley with 1,600 mature cows would require approximately 2,734 additional acres (3,200 acres – 467 acres). Information from the USDA National Agricultural Statistics Service indicates that there are currently 965 dairies and 1.5 million milk and dry cows in the Valley. Therefore, 1.5 million acres of irrigated pasture would need to be available for grazing if dairy cows in the Valley graze for just six months and 3 million acres of irrigated pasture would need to be available for dairy cows in the Valley to graze for the entire year.

Because the amount of land needed is not available, this mitigation measure is not feasible in the Valley. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Feed Additives for Poultry - ***(applies to poultry only)***

Feed additives such as minerals, antibiotics, and digestive aids are another option to mitigate emissions. These additives can allow for improved nutrient absorption and minimize nitrogen excretion. Feed additives are a mitigation option included in District Rule 4570 for poultry.

Feed additives are more commonly used with poultry than with ruminants, such as cattle, because of the differences in how the digestive system works in ruminants compared to poultry. Additives in the feed of poultry operations can be absorbed by these animals. However, feed and feed additives are pre-digested by rumen bacteria prior to being absorbed in the digestive system of ruminants, which may alter the composition of many feed additives. The use of the rumen bacteria in the digestive system of ruminants that pre-digest feed allows cattle, and other ruminants to utilize various feeds that cannot be digested by non-ruminants.

[70] Meyer, D., Price, P.L., Rossow, H.A., Silva-del-Rio, N., Karle, B., Robinson, P.H., DePeters, E.J., and Fadel, J. (2011) Survey of dairy housing and manure management practices in California. Journal Dairy Sci. 94:4744-4750. https://doi.org/10.3168/jds.2010-3761

Rule 4570 requires owners/operators of a layer CAF to implement at least one of the following feed mitigation measures:

- Feed according to NRC guidelines; or
- Feed animals probiotics designed to improve digestion according to manufacturer recommendations; or
- Feed animals an amino acid supplemented diet to meet their nutrient requirements; or
- Feed animals feed additives such as amylase, xylanase, and protease, designed to maximize digestive efficiency according to manufacturer recommendations.

Feed is one of the most significant costs for confined animal facilities, therefore producers work with nutritionists to design diets that maximize feed efficiency, increase feed adsorption, and reduce costs. For poultry, it is estimated that genetic selection and the current feed practices have reduced nitrogen excretion by poultry by up to 55 percent.

There are challenges to increase usage of feed additives. Feed is one of the most significant costs of production and feed additives will increase feed costs due to the time and expense of diet formulation and feed additive acquisition. Some additives have negative effects and may increase emissions of some pollutants. The use of antibiotics as feed additives has also been subject to greater restrictions because of efforts to combat increasing bacterial resistance to antibiotics.

The Reference Guide states that many feed additives are already “regularly used to improve nutrient absorption from feed ingredients.” Although the Reference Guide suggests that feed additives may improve nutrient absorption and decrease emissions of some pollutants, it does not specify which additives reduce which pollutants for different animals or the amount of each additive required.

Although the suggested measure lacks the specificity needed for a regulation, confined animal facilities already formulate diets to maximize nutrient adsorption, including the use of various feed additives. In addition, Rule 4570 includes feeding animals in accordance with NRC Guidelines, which includes specific nutrient requirements for different animals, and the option to utilize various feed additives. Therefore, because this measure is already used by the confined animal facilities in the Valley and included in Rule 4570, any ammonia reductions from this measure are already being achieved in the District.

It is critical for farmers to have the flexibility to decide the kind of mitigation measures that will work best for their specific operation by taking into consideration animal health and welfare, productivity, food safety and overall bio-security issues. The District’s menu of feeding options in Rule 4570 provides farmers with this flexibility, while also requiring the most stringent measures for controlling emissions from confined animal facilities.

Animal Confinement (Housing)

Table 4-10 Animal Confinement Measures Evaluated

Method	Measure	CAF Type	Reference
Biofilters and Wet Scrubbers	Enclosed Barns with Biofiltration Systems	Dairy	Kresge[71]
	Biofilters	All	NRCS[72]
	Install Air-Scrubbers or Biotrickling Filters to Mechanically Ventilated Pig Housing	Swine	Price[73]
	Air Scrubbing Techniques	All	Guthrie[74]
	Wet Scrubbers	All	NRCS
Washing Floors/Lanes	Clean Lanes at Dairies	Dairy	Beene[75]
	Washing Floors and Other Soiled Areas in Livestock Facilities	All	Guthrie
	Scrape/Flush Freestall Lanes	Dairy	Mendes[76]
	Washing Down Dairy Cow Collecting Yards	Dairy	Price
Corral Management	Constantly Manage Corrals	Dairy	Card[77]
	Frequency of Corral Manure Management	Dairy	Schmidt[78]
Floor Design	Floor Design Including Slates, Grooves, V-Shaped Gutters and Sloping Floors to Collect and Contain Slurry Faster	Dairy, Swine	Guthrie
	Part-slatted Floor Design for Pig Housing	Swine	Price
	Adapt Dairy Housing	Dairy	Pinder[79]

[71] Kresge, L., Strochlic, R. (2007). Clearing the Air: Mitigating the Impact of Dairies on Fresno County's Air Quality and Public Health. California Institute for Rural Studies.
[72] EPA-USDA NRCS. "Reference Guide for Poultry and Livestock Production Systems." September 2017. Retrieved from: https://www.epa.gov/sites/default/files/2017-01/documents/web_placeholder.pdf
[73] Price et al., "An Inventory of Mitigation Methods and Guide to their Effects on Diffuse Water Pollution, Greenhouse Gas Emissions and Ammonia Emissions from Agriculture, User Guide," December 2011. Retrieved from: https://repository.rothamsted.ac.uk/download/942687eab7ec4b83751c7e241d62f0fa8472d72adcd25a149bb891b7c30d55d0/1595300/MitigationMethods-UserGuideDecember2011FINAL.pdf
[74] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). The Impact of Ammonia Emissions from Agriculture on Biodiversity. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html
[75] Beene, M., Krauter, C., Goorahoo, D. (2005). Ammonia Fluxes from Animal Housing at a California Free Stall Dairy. California State University, Fresno. Center for Irrigation Technology and Plant Science Department. Retrieved from: https://www3.epa.gov/ttnchie1/conference/ei15/session6/beene.pdf
[76] Mendes, L.B., Pieters, J.G., Snoek, D., Ogink N.W.M., Brusselman, E., Demeyer, P. (2017). Reduction of Ammonia Emissions from Dairy Cattle Cubicle Houses via Improved Management or Design-Based Strategies: A Modeling Approach, In *Science of The Total Environment*, Volume 574, 2017, Pages 520-531, ISSN 0048-9697. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0048969716319970?via%3Dihub
[77] Card, T. and Schmidt, C. (May 2006). Dairy Air Emissions Report: Summary of Dairy Emission Estimation Procedures. Final Report to CARB.
[78] Schmidt, C.E., T. Card, P. Gaffney, and S. Hoyt. (2005). Assessment of Reactive Organic Gases and Amines from a Northern California Dairy Using the EPA Surface Emissions Isolation Flux Chamber. Presented at the 14th Annual Emission Inventory Conference of the U.S. Environmental Protection Agency, Las Vegas, NV.
[79] Pinder, R., Adams, P., Pandis, S. (2007). Ammonia Emission Controls as a Cost-Effective Strategy for Reducing Atmospheric Particulate Matter in the Eastern United States. *Environmental Science and Technology*, Volume 41, Pages 380-386. Retrieved from: https://pubs.acs.org/doi/pdf/10.1021/es060379a

Method	Measure	CAF Type	Reference
	Separate Urine/Manure with 3% Floor Slope	Dairy	Braam[80]
Additional Straw Bedding	Additional Targeted Straw-bedding for Cattle Housing	All cattle	Price
	Straw Bedding for Cattle Housing	All cattle	Guthrie
Other Housing	Optimal Barn Acclimatization with Roof Insulation and/or Automatically Controlled Natural Ventilation	All	Guthrie
	Oil Spray/Sprinkling	Swine	NRCS
	Convert Caged Laying Hen Housing from Deep-Pit Storage to Belt Manure Removal	Poultry	Price
	More Frequent Manure Removal from Laying Hen Housing with Belt Clean Systems	Poultry	Price
	In-House Poultry Manure Drying	Poultry	Price

Biofilters - ***(applies to all CAFs)***

A biofilter is an air filtration and odor mitigation system that channels building exhaust through a mixture of organic materials that support microbial growth. Biofilters have been identified in several publications as a potential ammonia mitigation method, including the NRCS Reference Guide. The NRCS Reference Guide notes many considerations that must be taken into account when implementing these systems, including that they require careful design, monitoring, and maintenance, and have very high associated costs.

Initial costs and challenges include the replacement of existing ventilation fans in order to provide the necessary airflow and the energy to overcome the added pressure drop caused by the biofilter. Biofilters require increased retention time; however increasing the retention time usually increases the system static pressure, which can compromise the ventilation system performance. It is typically not practical to treat all of the exhaust air during the summer when a large amount of ventilation flow is required to remove excessive heat from the production house. Lower ventilation airflow may also lead to heat stress in the animals.

Different types of biofilters have their own disadvantages. Flat open biofilter beds are easier to construct and generally cost less; however, they require very large footprints. Vertical biofilters are more difficult to construct and are more expensive, and biological material can settle, causing air leaks, which will reduce the performance of the system. In addition, biofilter media will need to be replaced periodically.

80 Braam, C., Ketelaars, J., Smits, M. (1997). Effects of floor design and floor cleaning on ammonia emission from cubicle houses for dairy cows, *Wageningen Journal of Life Sciences*. Retrieved from: https://library.wur.nl/ojs/index.php/njas/article/view/525

Biofilters require ongoing maintenance to prevent air leakage, dust accumulation, and air constriction in the media to ensure effectiveness of the system performance. Monitoring and maintenance of the filter media moisture is essential to operation of the biofilter, and sprinklers or other wetting systems may be required. Rodents and weeds have also been a problem for some biofilters.

Included in Appendix B of the Ammonia Supplemental Information for the 15 μg/m^3 SIP Revision, is a cost-effectiveness analysis that demonstrates the economic infeasibility of biofilters. District Rule 4570 does provide options for facilities to use emissions control devices such as biofilters; however, it is not feasible to require all facilities subject to Rule 4570 to install biofilters as they are not cost-effective or practical for livestock facilities in the Valley. The District has concluded that the measure discussed is not a viable mitigation measure to require in Rule 4570.

Air-Scrubbers/Wet Scrubbers - ***(applies to all CAFs)***

Several compilations of mitigation measures, including the NRCS Reference Guide and UK User Guide, list air scrubbing as a potential method of capturing ammonia from animal housing; however, there are considerable costs and challenges associated with the implementation of scrubbers at animal facilities. One such challenge is that off-the-shelf industrial scrubbers are typically not applicable to animal production systems, due to the variation and dynamic changes of such biological systems (e.g., housing structure variation, changes in ventilation airflow rate/pattern in response to the changes of air temperature, manure management practices, unique PM characteristics).

The practicality of scrubbers is limited due to their potential to compromise the ventilation airflow rate needed to control temperature in production houses to ensure animal health. There are added costs for the replacement of existing ventilation fans in order to provide the necessary airflow and the energy to overcome the added pressure drop because of the scrubber. Additionally, it is typically not practical to treat all of the exhaust air during the summer when a large amount of ventilation flow is required to remove excess heat from the production house and prevent heat stress in the animals.

Additional costs and challenges to scrubbers include the ongoing maintenance required to prevent dust accumulation and air constriction in the media to ensure effectiveness of the system performance. There are also potential dangers in transporting and handling materials such as acid used in the scrubber. Furthermore, wet scrubbers require large supplies of water and special wastewater handling systems that are not typical at animal production operations. This increased water usage is not practical in the Valley because of limited availability of water due to drought and increasing restrictions on the amount of usable groundwater, due to SGMA.

The UK User Guide identifies installing air-scrubbers as a mitigation method specifically for pig housing, however, concludes that the practical application of this method is only to new purpose-built buildings. Included in Appendix B of the Ammonia Supplemental Information for the 15 μg/m^3 SIP Revision is a cost-effectiveness analysis of scrubbers for swine facilities. The District found that scrubbers are not cost effective, and are therefore not technologically or economically feasible to require in the Valley. District Rule 4570 does provide options for facilities to use emissions control devices such as scrubbers; however, it is not feasible to require all facilities subject to Rule 4570 to install scrubbers. The District has concluded that the measure discussed is not a viable mitigation measure to require in Rule 4570.

<u>Washing Floors/Lanes</u> - *(applies to all CAFs)*

Several publications include the washing of floors and other soiled areas in livestock facilities as a potential mitigation method to reduce ammonia emissions. The UK User Guide includes a more specific measure involving washing down the concrete areas where dairy cows are collected prior to and after each milking even, through pressure washing or by hosing and brushing.

District Rule 4570 includes the requirement to clean the manure from the lanes, where the majority of manure is excreted, at dairies and other cattle facilities. The majority of cow holding areas at Valley dairies are equipped with sprinkler pens for washing the cows, and are periodically washed throughout the day, rather than scraped once per day.[81] Additionally, Rule 4570 requires constant washing of milking parlor floors to remove manure, which is also standard practice for California dairies. It is essential for all areas of milking parlors, including the milking parlor floors, to be the one of the cleanest parts of the dairy to ensure that the milk from the cows is clean and uncontaminated. There is a constant need for flushing and cleaning of the milking parlor because milk that is contaminated cannot be sold. Therefore, whenever practical, Rule 4570 requires cleaning of areas where the majority of manure accumulates.

Operators of dairy CAFs are required to implement several mitigation measures related to the cleaning of floors/lanes to comply with District Rule 4570, including the following:

<u>Required Measures:</u>

- Flush or hose milking parlor immediately prior to, immediately after, or during each milking;
- Pave feedlanes, where present, for a width of at least 8 feet along the corral side of the feedlane fence for milk and dry cows and at least 6 feet along the corral side of the feedlane for heifers; and
- Flush, scrap, or vacuum freestall flush lanes immediately prior to, immediately after, or during each milking; or flush or scrape freestall flush lanes at least 3 times per day.

[81] Chang, A., T. Harter, J. Letey, D. Meyer, R. D. Meyer, M. Campbell-Mathews, F. Mitloehner, S. Pettygrove, P. Robinson, R. Zhang (2006) Managing Dairy Manure in the Central Valley of California; University of California Committee of Experts on Dairy Manure Management Final Report to the Regional Water Quality Control Board, Region 5, Sacramento, June 2005. https://ucanr.edu/sites/groundwater/files/136450.pdf

Additional Measures (must select at least one of the following):

- Use non-manure-based bedding and non-separated solids based bedding for at least 90 percent of the bedding material, by weight, for freestalls;
- For a large dairy CAF, remove manure that is not dry from individual cow freestall beds or rake, harrow, scrape, or grade freestall bedding at least once every 7 days; or
- For a medium dairy CAF, remove manure that is not dry from individual cow freestall beds or rake, harrow, scrape, or grade freestall bedding at least once every 14 days.

Operators of other cattle CAFs are required to implement the following mitigation measures to comply with District Rule 4570:

- Vacuum, scrape, or flush freestalls at least once every 7 days;
- Pave feedlanes, where present, for a width of at least 6 feet along the corral side of the feedlane; and
- Either use non-manure-based bedding and non-separated solids based bedding for at least 90 percent of the bedding material, by weight, for freestalls; or remove manure that is not dry from individual cow freestall beds or rake, harrow, scrape, or grade bedding in freestalls at least once every seven days.

In conclusion, the District already requires mitigation measures that require CAFs to wash floors and/or lanes inside of cow housing areas. No additional ammonia reductions are expected from the suggested mitigation measure.

Corral Management - ***(applies to all cattle)***

Proper management of manure in animal housing areas will stabilize the nitrogen compounds, which will reduce the rate that these compounds are converted to ammonia that can be lost to the atmosphere. Research by Card and Schmidt (2005) supports that management of manure in corrals reduces ammonia emissions from the corrals and points out that of two dairies tested, the ammonia emissions from the dairy with constantly managed corrals had “exceptionally low ammonia emissions.” Follow-up research by Card and Schmidt (2009) at one of the dairies studied indicated that ammonia emissions were significantly reduced (>80 percent reduction comparing 2008 to 2005 reported ammonia emissions) when the frequency of management of the manure in the corrals was increased.

Rule 4570 includes requirements for management of corrals to prevent excessive buildup of manure, designing or managing corrals to prevent excessive moisture, and periodic scraping and removal of manure from corrals. Under Rule 4570, dairy, beef feedlot, and other cattle facilities are required to implement four to six measures for corral management depending on facility type, as well as select one additional mitigation measure as detailed below:

Required Measures

- Pave feedlanes, where present, for a width of at least 8 feet along the corral side of the feedlane fence for milk and dry cows and at least 6 feet along the corral side of the feedlane for heifers (*dairy and other cattle*);
- Clean manure from corrals at least 4 times per year with at least 60 days between cleaning; or clean corrals at least once between April and July and at least once between September and December (*dairy*);
- Scrape corrals twice a year with at least 90 days between cleanings, excluding the removal of in-corral mounds (*beef feedlot and other cattle*);
- Scrape, vacuum or flush concrete lanes in corrals at least once every day for mature cows and every 7 days for support stock; or clean concreted lanes such that the depth of manure does not exceed 12 inches at any point or time (*dairy and other cattle*);
- Inspect water pipes and troughs and repair leaks at least once every 7 days;
- Choose one of the following:
    - Slope the surface of the corrals at least 3 percent where the available space for each animal is 400 square feet or less. Slope the surface of the corrals at least 1.5 percent where the available space for each animal is more than 400 square feet per animal;
    - Maintain corrals to ensure proper drainage preventing water from standing more than 48 hours; or
    - Harrow, rake, or scrape corrals sufficiently to maintain a dry surface; and
- If the CAF has shade structures, they must choose one of the following:
    - Install shade structures such that they are constructed with a light permeable roofing material;
    - Install all shade structures uphill of any slope in the corral;
    - Clean manure from under corral shades at least once every 14 days, when weather permits access into the corral (*dairy*); or
    - Install shade structure so that the structure has a North/South orientation.

Additional Measures

- Manage corrals such that the manure depth in the corral does not exceed 12 inches at any time or point, except for in-corral mounding. Manure depth may exceed 12 inches when corrals become inaccessible due to rain events. The facility must resume management of the manure depth of 12 inches or lower immediately upon the corral becoming accessible.
- Knockdown fence line manure build-up prior to it exceeding a height of 12 inches at any time or point. Manure depth may exceed 12 inches when corrals become inaccessible due to rain events. The facility must resume management of the manure depth of 12 inches or lower immediately upon the corral becoming accessible.
- Use lime or a similar absorbent material in the corral according to the manufacturer's recommendation to minimize moisture in the corrals; or apply

thymol to the corral soil in accordance with the manufacturer's recommendation (*dairy and other cattle*).

In conclusion, the District already requires mitigation measures that minimize emissions from corral housing areas. No additional ammonia reductions are expected from the suggested mitigation measure.

Floor Design - ***(applies to dairy cattle and swine only)***

Several publications list different floor design types for collecting and containing slurry that may reduce ammonia emissions that include slats, grooves, v-shaped gutters, and sloping floors. The measures included in these documents are applicable to small dairies in which cows are kept in stables or cubicle-type housing that is common on small European dairies in which manure was allowed to accumulate. These measures are also applicable to manure handled as a slurry, and does not apply to the larger dairies in the Valley that are subject to District permitting, which handle very little manure as a slurry.[82] It should also be noted that most physical changes to existing dairy barns must be incorporated at the design stage, and are not practical for existing structures, resulting in significantly higher capital costs.

Valley dairies have paved lanes to facilitate manure removal, as required by Rule 4570. The lanes on the dairies are sloped to allow manure to be sent to a lagoon system. In addition, Rule 4570 requires that manure must be periodically removed from the lanes where the cattle spend the majority of their time. Therefore, Rule 4570 already incorporates control measures for specialized floor design and this is already being implemented by dairies in the Valley.

Rule 4570 requirements for dairy and other cattle facilities are as follows:

- Pave feedlanes, where present, for a width of at least 8 feet along the corral side of the feedlane fence for milk and dry cows and at least 6 feet along the corral side of the feedlane for heifers and other cattle; and
- For corrals, choose one of the following:
    - Slope the surface of the corrals at least 3 percent where the available space for each animal is 400 square feet or less. Slope the surface of the corrals at least 1.5 percent where the available space for each animal is more than 400 square feet per animal;
    - Maintain corrals to ensure proper drainage preventing water from standing more than 48 hours;
    - Harrow, rake, or scrape corrals sufficiently to maintain a dry surface.

The UK User Guide includes a floor design measure specifically for swine that aims to reduce the overall emitting surface area of slurry by replacing fully slatted floors with

[82] Marklein, A. R., Meyer, D., Fischer, M. L., Jeong, S., Rafiq, T., Carr, M., and Hopkins, F. M. (2021) Facility-scale inventory of dairy methane emissions in California: implications for mitigation, Earth Syst. Sci. Data, 13, 1151–1166, https://doi.org/10.5194/essd-13-1151-2021, 2021.

part-slatted floors. This type of floor design is already a requirement at the only swine facility in the District. The facility has a specific permit condition that states “Permittee shall use a slatted floor system (slatted floors over deep pits or shallow flush alleys), with daily manure removal for shallow flush alleys and weekly removal from deep pits.” Under Rule 4570, swine CAFs are required to implement measures for animal housing that includes the use of a similar slatted floor system, as follows:

- Use a slatted floor system (slatted floors over deep pits or shallow flush alleys), with daily manure removal for shallow flush alleys and weekly removal from deep pits.

In conclusion, the District already requires a mitigation measure for swine CAFs to minimize emissions from animal housing areas through the use of a slatted floor system. No additional ammonia reductions are expected from the suggested mitigation measure.

Separate Urine/Manure with 3 Percent Floor Slope - ***(applies to dairy cattle only)***

In one study[83] completed in the Netherlands, ammonia emissions from cubicle housing with a slatted floor, used on small dairies in Europe, were compared with two different solid floor systems: a non-sloped and a 3 percent one-sided sloped floor, combined with a highly frequent or normal removal of manure by a scraper. The study results indicated that the slope of the floor had more impact on reducing ammonia emissions than increasing the scraping frequency. Solid floors with a slope decreased ammonia emissions compared to slatted floors. However, the study indicated that solid floors without a slope may not decrease ammonia emission compared with slatted floors.

Cubicle housing with slatted floors and manure pits under the housing areas are not used for dairy cattle in the Valley. The typical practice is to house cattle in barns or corrals with flushed or scraped lanes. These lanes are sloped to facilitate flushing of the manure to the lagoon system. Additionally, Rule 4570 includes requirements that corrals be sloped, which allows urine to drain away, which reduces the conversion of urea in urine to ammonia since it will have less contact with enzymes in feces that promote this transformation.

District Rule 4570 requires dairy, beef feedlot, and other cattle facilities to implement the following mitigation measure, or an equivalent measure:

- Slope the surface of the corrals at least 3 percent where the available space for each animal is 400 square feet or less. Slope the surface of the corrals at least 1.5 percent where the available space for each animal is more than 400 square feet per animal.

[83] Braam, C., Ketelaars, J., Smits, M. (1997). Effects of floor design and floor cleaning on ammonia emission from cubicle houses for dairy cows, *Wageningen Journal of Life Sciences*. Retrieved from: https://library.wur.nl/ojs/index.php/njas/article/view/525

In conclusion, the District Rule 4570 already includes mitigation measures involving sloped floors for cattle facilities. No additional ammonia reductions are expected from the suggested mitigation measure.

Additional Targeted Straw-Bedding for Cattle Housing - ***(applies to dairy and other cattle only)***

This method involves adding extra straw bedding to cattle houses, targeting the wetter and dirtier areas of the house. This measure is applicable to small dairy farms that house cattle indoors and use a solid manure handling system, such as small dairy farms in Europe; however, most dairies in the Valley handle the majority of the manure as a liquid and do not use straw bedding. One study[84] indicated that storage or treatment ponds were found on 95.9 percent of dairies, and another report prepared for CARB states that, "*California dairy effluent often runs 1 percent total solids*."[85] These dairies also use frequent flushing to remove the manure instead of absorbing with straw, thereby reducing emissions through flushing. Beef cattle in the Valley are not housed indoors; therefore, this measure would not apply to beef cattle in the Valley.

For areas of the dairy that would benefit from this method, the use of straw, or other non-manure based bedding for cow housing is included as a menu option for cattle housed in barns, as shown below:

- Use non-manure-based bedding and non-separated solids based bedding for at least 90 percent of the bedding material, by weight, for freestalls (e.g. rubber mats, almond shells, sand, or waterbeds).

In conclusion, the District already has a mitigation measure option to minimize emissions from cow bedding. No additional ammonia reductions are expected from the suggested mitigation measure.

Optimal Barn Acclimatization with Roof Insulation and/or Automatically Controlled Natural Ventilation - ***(applies to all CAFs)***

The compilation by Guthrie, et al.[86] includes ammonia mitigation measures that involve specific building design to provide optimal barn acclimatization. This measure was based on information from the United Nations Economic Commission for Europe (UNECE) compilation Framework Code for Good Agricultural Practice for Reducing

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[84] Meyer, D., Price, P.L., Rossow, H.A., Silva-del-Rio, N., Karle, B., Robinson, P.H., DePeters, E.J., and Fadel, J. (2011) Survey of dairy housing and manure management practices in California. Journal Dairy Sci. 94:4744-4750. https://doi.org/10.3168/jds.2010-3761

[85] Meyer, D, Heguy, J., Karle, B. and Robinson, P. (2019) Characterize Physical and Chemical Properties of Manure in California Dairy Systems to Improve Greenhouse Gas Emission Estimates. California Environmental Protection Agency, Air Resources Board. https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/past/16rd002.pdf

[86] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). The Impact of Ammonia Emissions from Agriculture on Biodiversity. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html

Ammonia Emissions.[87] The UNECE publication stated that for cattle cubicle housing was considered the reference and that for cattle housed in cubicles with traditional slats, and claimed that this measure can moderately reduce ammonia by 20 percent compared to conventional cubicle housing.

Cubicle housing with traditional slats is not typically used to house cattle in the Valley; therefore, this measure is not applicable to cattle in the Valley. In cubicle housing with traditional slats, the manure that cattle excrete seeps through the slats and falls to an alley or a storage pit below the housing area. In the Valley, dairy cattle are typically housed in barns or corrals with lanes that are flushed or scraped to remove manure to a separate area for storage. In cubicle housing with traditional slats, a large amount of the ammonia emissions are from the manure stored in an alley or pit below the housing area. Therefore, this measure would not reduce ammonia emissions from cattle housing in the Valley because manure is stored in a different area.

In addition, these measures are not feasible for many existing buildings and must be incorporated in the initial design stage of a new build. For poultry, new houses generally incorporate insulation and controlled ventilation. However, this measure is generally not feasible for implementation at Valley dairies or other cattle facilities. Due to the warm climate in the Valley, barns used for cattle consist of a roof with open sides to allow for adequate airflow and cooling. These structures would need to be completely redesigned and reconstructed to implement this mitigation measure, and there would be substantial cost to enclose the cattle and equip the barns with ventilation systems to supply sufficient airflow for the cattle. Furthermore, the increased airflow from the fans required for ventilation may promote increased emissions from the barns rather than reduce ammonia.

In conclusion, the suggested measure is not applicable to cattle facilities in the Valley and would not result in any additional ammonia reductions.

Oil Spray/Sprinkling - ***(applies to swine only)***

Sprinkling of vegetable oil in animal production areas has been demonstrated as an effective measure within swine barns for PM mitigation, with observed smaller reductions of ammonia ranging from 0-30 percent. However, results of research on the effect of this practice on ammonia emissions vary greatly.[88] This practice requires daily labor if applied by hand, and requires additional time during room washing to remove oil residue. Additionally, oil residue can cause ventilation fans to become stuck in on or off positions, preventing them from operating correctly to ensure proper ventilation and cooling of animals. As mentioned above, current research shows considerable

[87] UNECE. 2015. United Nations Economic Commission for Europe Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions. United Nations Economic Commission for Europe Convention on Long-range Transboundary Air Pollution. https://unece.org/environment-policy/publications/framework-code-good-agricultural-practice-reducing-ammonia

[88] Harmon, J., Hoff, S., Rieck-Hinz, A. (2014). Animal Housing – Vegetable Oil Sprinkling Overview. *Air Management Practices Assessment Tool*, Iowa State University. Retrieved from: https://store.extension.iastate.edu/product/Animal-Housing-Vegetable-Oil-Sprinkling-Overview

variability in the potential ammonia emission reductions of this measure; therefore, it is currently uncertain if this measure will reduce ammonia emissions and the magnitude of any potential reductions. Furthermore, the NRCS Reference Guide indicates that this measure is applicable to swine barns, which contribute a very small amount to the District's ammonia inventory with only one permitted facility in the Valley. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Convert Caged Laying Hen Housing from Deep-Pit Storage to Belt Manure Removal - *(applies to poultry only)*

This measure applies to high-rise laying hen housing with deep pit storage. In a deep-pit storage system, laying hens are kept in tiered cages and the manure from laying hens drops into a pit below the cages where it may be stored for months prior to removal. The UK User Guide identifies that replacing this system with a series of belts below each tier of cages, which remove manure from the house, could have the potential to reduce ammonia emissions.

In the United States, the overall trend for farms that produce eggs has been to shift away from high-rise laying hen housing with tiered cages to cage-free housing. In 2018, voters in California approved Proposition 12, also known as the Farm Animal Confinement Initiative.[89] Proposition 12 requires that animals held in buildings, such as laying hens, breeding sows, or veal calves, *"be housed in confinement systems that comply with specific standards for freedom of movement, cage-free design, and minimum floor space."* Implementation of the law began on January 1, 2022, and as a result all eggs produced in California must be procured only from hens in cage-free housing. High-rise hen houses in which egg-laying hens are kept in cages are no longer legal in California. There are significant questions that need to be answered regarding the practicality, cost, and overall ammonia emission reductions of implementing this measure for cage-free hen houses. Therefore, the District has concluded that this measure is not a viable mitigation option to include in Rule 4570 at this time.

More Frequent Manure Removal from Laying Hen Housing with Belt Clean Systems - *(applies to poultry only)*

This method identified in the UK User Guide increases the frequency of manure removal to twice weekly, and relies on the rapid removal of manure from the house prior to the peak rate of ammonia emission. This measure is only applicable to laying hen houses that are already equipped with belt manure removal systems, and is not feasible for the majority of existing laying hen houses in the Valley given the significant facility reconstruction costs and potential space/infrastructure limitations at existing facilities. In addition, as explained above, all eggs produced in California must be procured only from hens in cage-free housing and there are significant questions that need to be answered regarding the practicality, cost, and overall ammonia emission reductions of implementing this measure for cage-free hen houses. Therefore, the District has

[89] California Proposition 12, Animal Care Program. Retrieved from: https://www.cdfa.ca.gov/AHFSS/AnimalCare/

concluded that this measure is not a viable mitigation option to include in Rule 4570 at this time.

In-House Poultry Manure Drying - ***(applies to poultry only)***

In-house poultry manure drying, as identified in the UK User Guide, is applicable to poultry housing, and involves the installation of ventilation/drying systems that reduce the moisture content of poultry litter. The author expects implementation of this method to be low to moderate, due to the practical limitations involved with installing systems in existing buildings. Forced air drying systems are not feasible for houses in which the birds are raised on litter because the litter remains in the houses with the birds until cleaned out to prepare for another flock. Following BACT Guidelines 5.7.1[90] and 5.7.2[91], this practice is evaluated as a potential BACT measure for new or expanding facilities; the required mitigation measure is as follows:

- Completely enclosed mechanically ventilated layer housing with evaporative cooling pads, mixing fans, and a computer control system.

In conclusion, the District already has a mechanism to implement this mitigation measure for expanding or new poultry housing operations. No additional ammonia reductions are expected from the suggested mitigation measure.

Manure Management (Storage)

Table 4-11 Manure Management (Storage) Measures Evaluated

Method	Measure	CAF Type	Reference
Lagoon Management	Replace Lagoons with Deep Tanks	Dairy	Guthrie[92]
	Oxygenation of Liquid Manure Lagoons	All	NRCS[93]
Storage Bags	Storage Bags	Dairy	Guthrie
Manure Storage Covers	Liquid Manure Storage Covers	All	NRCS
		All	Marks[94]
	Solid Manure Storage Covers	All	NRCS

[90] https://ww2.arb.ca.gov/sites/default/files/classic/technology-clearinghouse/bact/BACTID773.pdf?:linktarget=_self&:embed=yes
[91] https://ww2.arb.ca.gov/sites/default/files/classic/technology-clearinghouse/bact/BACTID774.pdf?:linktarget=_self&:embed=yes
[92] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). The Impact of Ammonia Emissions from Agriculture on Biodiversity. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html
[93] EPA-USDA NRCS. "Reference Guide for Poultry and Livestock Production Systems." September 2017. Retrieved from: https://www.epa.gov/sites/default/files/2017-01/documents/web_placeholder.pdf
[94] Marks, R. (2001). Cesspools of Shame: How Factory Farm Lagoons and Sprayfields Threaten Environmental and Public Health. *Natural Resources Defense Council and the Clean Water Network.* Retrieved from: https://www.nrdc.org/sites/default/files/cesspools.pdf

Method	Measure	CAF Type	Reference
		All	Price[95]
		All	Chadwick[96]
	Allow Cattle Slurry Stores to Develop a Natural Crust	Dairy	Price
Solid-Liquid Separation	Solid-Liquid Separation	All	NRCS
Anaerobic Digesters	Anaerobic Digesters	Dairy	NRCS
		Dairy	Marks
		Dairy	Kresge[97]
Amendments/Additives	Litter Amendments and Manure Additives	All	NRCS
	Acidifying Slurry and Shifting Chemical Balance from Ammonia to Ammonium	All	Guthrie
	Acidifying Amendments and Additives for Poultry Litter	Poultry	Price
	Urease Inhibitors	All Cattle	Pinder[98]
		All Cattle	Preece[99]
Surface Cooling	Surface Cooling of Slurry Manure	All	Guthrie
pH of Manure	Lowering pH of Manure	All	Preece
On-farm Composting	Composting	All Cattle	NRCS

Replace Lagoons with Deep Tanks - ***(applies to dairy cattle only)***

A compilation[100] indicated that replacing lagoons with deep tanks can reduce ammonia emissions by 30-60 percent. The information from the compilation indicates that this

[95] Price et al., "An Inventory of Mitigation Methods and Guide to their Effects on Diffuse Water Pollution, Greenhouse Gas Emissions and Ammonia Emissions from Agriculture, User Guide," December 2011. Retrieved from: https://repository.rothamsted.ac.uk/download/942687eab7ec4b83751c7e241d62f0fa8472d72adcd25a149bb891b7c30d55d0/1595300/MitigationMethods-UserGuideDecember2011FINAL.pdf
[96] Chadwick, D.R. (2005). Emissions of Ammonia, Nitrous Oxide and Methane from Cattle Manure Heaps: Effect of Compaction and Covering. *Atmosphere Environment*, Vol. 39, Issue 4: 787-799. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S135223100400994X
[97] Kresge, L., Strochlic, R. (2007). Clearing the Air: Mitigating the Impact of Dairies on Fresno County's Air Quality and Public Health. *California Institute for Rural Studies.*
[98] Pinder, R., Adams, P., Pandis, S. (2007). Ammonia Emission Controls as a Cost-Effective Strategy for Reducing Atmospheric Particulate Matter in the Eastern United States. *Environmental Science and Technology*, Volume 41, Pages 380-386. Retrieved from: https://pubs.acs.org/doi/pdf/10.1021/es060379a
[99] Preece, S., Cole, N., Todd, R., Auvermann, B. (2017). Ammonia Emissions from Cattle Feeding Operations. *Texas A&M AgriLife Extension Service.* Retrieved from: http://baen.tamu.edu/wp-content/uploads/sites/24/2017/01/E-632.-Ammonia-Emissions-from-Cattle-Feeding-Operations.pdf
[100] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). The Impact of Ammonia Emissions from Agriculture on Biodiversity. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html

measure is applicable to manure that is handled as a slurry. The reductions in ammonia emissions are a result of the smaller surface area of the manure in contact with the air from which ammonia may be emitted. Storage of manure in deep tanks is not a feasible measure for the District due to the size of dairies in the Valley and the way that manure is typically handled. As previously mentioned, the average dairy in the Valley has almost 1,600 cows compared to a national average of less than 300 cows per dairy outside of California[101, 102] and are larger than the typical European dairies for which this measure was considered. In addition, dairies in the Valley typically handle liquid manure as a dilute liquid rather than a thick slurry. The dilute dairy manure typically handled in the Valley has a solids content of 2 percent or less while slurry manure has a solids content of about 10 percent. As a result, the volume of manure handled would be approximately 27 times greater than the average dairy outside of California that handles dairy manure as a slurry. It is not practical to construct tanks that would contain such large amounts of manure. Notably, the depth of lagoons and storage ponds is limited to protect groundwater because a minimum distance is required between the bottom of the lagoons and storage ponds and the groundwater.[103,104] Therefore, the tanks would need to be constructed aboveground. However, it is not practical to construct tanks aboveground because of the large amount of liquid manure that must be stored. Pumping the manure into aboveground tanks would require larger amounts of energy. Also, it is possible the release of the ammonia conserved in the manure tanks will be delayed until the manure is sent to a storage pond or applied to land. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Oxygenation of Liquid Manure Lagoons - ***(applies to all CAFs)***

The NRCS Reference Guide states that large land footprint of naturally aerobic lagoons is not practical for many farms. This is particularly applicable to the large farms in the Valley. Naturally aerobic lagoons are not feasible in the Valley because the dairies in the Valley would require an extremely large footprint. The design criteria of naturally aerobic lagoons in the USDA-NRCS Practice Standard Code 359 will be used to illustrate the approximate size that would be required for naturally aerated lagoons for confined animal facilities in the Valley. USDA-NRCS Practice Standard Code 359 requires that naturally aerobic lagoons be designed to have a minimum treatment surface area as determined on the basis of daily BOD_5 loading per unit of lagoon surface. The standard specifies that the maximum loading rate of naturally aerobic lagoons shall not exceed the loading rate indicated by the USDA-NRCS Agricultural

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[101] Hanson, M. (2021) U.S. Dairy Herd Hits 27-year High. *Dairy Herd Management.* Retrieved from: https://www.dairyherd.com/news/dairy-production/us-dairy-herd-hits-27-year-high

[102] Latest USDA Statistics for average size of dairies excluding California. Retrieved from: https://downloads.usda.library.cornell.edu/usda-esmis/files/h989r321c/7d279w693/f7624g40c/mkpr0222.pdf (about 270 cows per dairy outside California)

[103] California Regional Water Quality Control Board Central Valley Region Order R5-2013-0122 – Reissued Waste Discharge Requirements General Order for Existing Milk Cow Dairies. Retrieved from: https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2013-0122.pdf

[104] California Regional Water Quality Control Board Central Valley Region Order R5-2017-0058 –Waste Discharge Requirements General Order for Confined Bovine feeding Operations. Retrieved from: https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2017-0058.pdf

Waste Management Field Handbook (AWMFH)[105] or the maximum loading rate according to state regulatory requirements, whichever is more stringent.

According to Figure 10-30 (August 2009) of the latest version of the AWMFH, the maximum aerobic lagoon lading rate for the Valley is 45 - 55 lb-BOD_5/acre-day. Based on information from the USDA National Agricultural Statistics Service, the average dairy in the Valley has approximately 1,600 milk and dry cows. Based on a typical dairy herd composition, the average dairy in the Valley is estimated to have approximately 1,348 milk cows, 252 dry cows, and 1,153 heifers and calves. According to Table 4-5 (March 2008) of the USDA-NRCS AWMFH, the total daily manure produced by each milk cow, dry cows, and 970 lb heifer will have an average BOD loading of 2.9 lb-BOD_5/day, 1.4 lb-BOD_5/day, and 1.2 lb-BOD_5/day, respectively. The average BOD loading of manure produced by smaller heifers and calves is estimated based on manure volatile solids excretion rates. Assuming that 80 percent of the manure will be flushed to the lagoon system, the minimum lagoon surface area required for a naturally aerobic lagoon treating manure from an average size dairy in the Valley with 1,600 milk and dry cows can be calculated as follows:

<u>BOD_5 loading (lb/day)</u>

1,348 milk cows x 2.9 lb-BOD_5/cow-day x 0.80 = 3,127 lb-BOD_5/day

252 dry cows x 1.4 lb-BOD_5/cow-day x 0.80 = 282 lb-BOD_5/day

457 heifers (15-24 months) x 1.2 lb-BOD_5/heifer-day x 0.80 = 439 lb-BOD5/day

366 heifers (7-14 months) x 0.83 lb-BOD_5/heifer-day x 0.80 = 243 lb-BOD_5/day

182 heifers (4-6 months) x 0.47 lb-BOD_5/heifer-day x 0.80 = 68 lb-BOD_5/day

148 calves (0-3 months) x 0.27 lb-BOD_5/heifer-day x 0.80 = 32 lb-BOD_5/day

Total BOD loading = 3,127 lb-BOD_5/day + 282 lb-BOD_5/day + 439 lb-BOD_5/day + 243 lb-BOD_5/day + = 68 lb-BOD_5/day + 32 lb-BOD_5/day = 4,191 lb-BOD_5/day

<u>Minimum Surface Area Required for a Naturally Aerobic Lagoon for an Average San Joaquin Valley Dairy</u>

Minimum Surface (acres) in areas with a maximum loading rate of 55 lb-BOD_5/acre-day = 4,191 lb-BOD_5/day ÷ 55 lb-BOD_5/acre-day = 76.2 acres

Minimum Surface (acres) in areas with a maximum loading rate of 45 lb-BOD_5/acre-day = 4,191 lb-BOD_5/day ÷ 45 lb-BOD_5/acre-day = 93.1 acres

[105] United States Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS), Agricultural Waste Management Field Handbook (AWMFH). Retrieved from: https://directives.sc.egov.usda.gov/viewerfs.aspx?hid=21430

As shown above the minimum surface area required for a naturally aerobic lagoon treating manure from an average size dairy in the Valley would range from approximately 76.2 – 93.1 acres. This amount of land is not typically available and would require the removal of land that is currently used to produce feed or other crops. Construction of a lagoon over 76 acres in size would be a massive project that would have numerous challenges and high costs for both design and construction. For example, the expense of lining a lagoon of this size would be extremely high. To comply with the requirements of the Central Valley Regional Water Quality Control Board, new lagoons and ponds that store dairy manure in the Valley have generally needed to comply with the Central Valley Regional Water Quality Control Board Tier 1 design standards, which require a lagoon or pond with a double liner constructed of high density polyethylene (HDPE) or material of equivalent durability with a leachate collection and removal system. The Capital Press article[106] indicated that the cost for the installation of double-liner for an existing lagoon at a dairy near Sunnyside, Washington in 2016 was roughly $500,000 for each lagoon and the lagoons averaged 78,000 square feet each. Based on this information, the cost of a double liner for a lagoon storing dairy manure is estimated to be about $7.88 per square foot and $343,253 per acre in 2022. Therefore, the cost for the liner for a lagoon only with an area of 76.2 to 93.1 acres would be $26,555,879 to $31,956,854.

In addition to construction costs, there would also be an increase in expenses for designing and maintaining lagoons of such a large size. To comply with the requirements of Regional Water Quality Control Board and Mosquito Abatement District the lagoon would need to be regularly cleared of any dead algae, vegetation, and floating debris that could create a habitat for mosquitos and other vectors that carry diseases. Therefore, as a result of the large size of the lagoons, the maintenance required to comply with these regulations would be difficult and there would also be increased costs. Finally, ammonia emissions may increase from naturally aerobic lagoons because of the large surface in contact with the atmosphere.

The NRCS Reference Guide states that the energy required at an animal production operation to introduce enough oxygen for complete aerobic treatment using mechanical aeration is very expensive and aeration of the surface of the liquid manure is more common.

The Government of Ontario publication[107] states that there are several disadvantages for on-farm use of mechanical aeration and specifically lists the following:

- High initial costs;
- High energy costs;
- High maintenance costs;

[106] Wheat, D. (2018). Dairy Installs Double Liner in Its Lagoon. Capital Press. Updated December 13, 2018. Retrieved from: https://www.capitalpress.com/state/washington/dairy-installs-double-liner-in-its-lagoon/article_9ded077e-db11-5cc5-adb7-aa7ebee6e5b9.html
[107] Government of Ontario. (2006). "Aeration of Liquid Manure". Retrieved from: https://www.ontario.ca/page/aeration-liquid-manurehttps://www.ontario.ca/page/aeration-liquid-manure

- Effectiveness is reduced in cold weather;
- The introduction of antibiotics and sanitizers can upset or destroy the required aerobic bacteria; and
- Nitrogen loss to the atmosphere is increased with mechanical aeration.

This publication cautions that improperly designed mechanical aeration systems may contribute more odor than what is reduced through the mixing of air into the liquid, which indicates that mechanical aeration of manure can increase emissions.
The very high cost of complete mechanical aeration makes this option infeasible for farms. For complete aerobic treatment of a lagoon, sufficient oxygen must be delivered into the lagoon and the oxygen delivered must be completely mixed throughout the lagoon. A report by the University of California (UC) Davis[108] states, "*Mixing is important to ensure uniformity of temperature and composition throughout the volume, e.g., continuous bulk turnover is needed to eliminate quiescent zones or sludge layers where anaerobic conditions persist. Also, relatively vigorous mixing (high turbulence) prevents clumping of organisms/substrate, and reduces diffusion resistance by thinning the film thickness through which dissolved oxygen must migrate (diffuse) to reach substrate particles and organisms.*" Delivery of oxygen and mixing of the oxygen throughout a lagoon requires substantial amounts of energy. The cost of electricity for complete aeration can be estimated based on the amount of oxygen that needs to be supplied and the energy required for complete mixing of oxygen throughout a lagoon. The Government of Ontario publication indicates that for complete aeration of manure, oxygen must be supplied in an amount equal to twice the BOD in the manure.

A publication[109] indicates that approximately 1.5 to 2.5 pounds of oxygen is required to digest one pound of Biological Oxygen Demand (BOD_5) with additional oxygen required for conversion of ammonia to nitrate (NO3-) (nitrification). In this publication, Dr. Ruihong Zhang of UC Davis estimated that 2.4 lbs (1.1 kg) of oxygen (O_2) per cow must be provided each day for removal of BOD and an additional 3 lbs (1.4 kg) per cow for oxidation of 70 percent of the nitrogen, which is a ratio of approximately 2.25 lb of oxygen per lb of BOD. It will be estimated that 2 lb of oxygen per 1 lb of BOD_5 is required for nitrification of ammonia.

As discussed above, the lagoons for an average size dairy in the Valley with 1,600 mature cows will have a BOD loading rate of approximately 4,191 lb-BOD_5/day. Based on the data gathered in the UC Davis report, aeration efficiencies for mechanical aerators ranged from 0.10 to 0.68 kg of oxygen provided per kW-hr of energy utilized.[110] The most efficient aerator tested installed in dairy lagoons had an aeration efficiency of 0.49 kg-O_2/kW-hr. These efficiency tests were performed in clean water. The efficiency

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[108] Williams, R.B., Elmashad, H., Kaffka, S. (2020). Research and Technical Analysis to Support and Improve the Alternative Manure Management Program Quantification Methodology. *University of California, Davis, California Biomass Collaborative*, CARB Agreement No. 17TTD010. Retrieved from: https://ww2.arb.ca.gov/sites/default/files/auction-proceeds/ucd_ammp_qm_analysis_final_april2020.pdf

[109] San Joaquin Valley Dairy Manure Technology Feasibility Assessment Panel. (2005) An Assessment of Technologies for Management and Treatment of Dairy Manure in California's San Joaquin Valley. California Air Resources Board

[110] Zhang, R., Sun, H., Kamthunzi, W.M., Collar, C.A., Mitloehner, F.M. (2007) Aerator Performance for Wastewater Lagoon Application, ASABE. https://elibrary.asabe.org/abstract.asp?aid=23832

of the aerators will be lower in liquid manure because of the higher amount of solids that it contains compared to clean water. The yearly energy requirement for a mechanically aerated lagoon treating flushed manure an average size dairy in the Valley is calculated as follows:

Oxygen Requirement for Average Size Dairy in the Valley

4,191 lb-BOD_5/day x 1 kg/2.2046 lb = 1,901 kg-BOD_5/day x 2 = 3,802 kg-BOD_5/day

Electricity for High Efficiency Aerator

3,802 kg-BOD_5/day ÷ (0.68 kg-O_2/kW-hr) x (365 day/year) = 2,040,779 kW-hr/year

Electricity for Low Efficiency Aerator

3,802 kg-BOD_5/day ÷ (0.10 kg-O_2/kW-hr) x (365 day/year) = 13,877,300 kW-hr/year

Electricity for Complete Mixing of Air

The UC Davis report estimates that mixing for complete aeration of a dairy lagoon would require 3,300 kW-hr per milk cow per year. The energy required for mixing for complete aeration for an average sized dairy in the Valley is calculated as follows:

1,348 milk cows x 3,300 kW-hr/milk cow-year = 4,448,400 kW-hr/year

Total Electricity Required for Complete Aeration with High Efficiency Aerator

2,040,779 kW-hr/year + 4,448,400 kW-hr/year = 6,489,179 kW-hr/yr

Total Electricity Required for Complete Aeration with Low Efficiency Aerator

13,877,300 kW-hr/year + 4,448,400 kW-hr/year = 18,325,700 kW-hr/yr

Cost of Electricity for Complete Mechanical Aeration of a Lagoon Treating Manure from an Average Size Dairy in the Valley:

The cost for electricity will be based upon the average price for industrial electricity in California for the year December 2021 through November 2022, as taken from the Energy Information Administration (EIA) website:

Average Cost for electricity = $0.1685/kW-hr

The electricity costs for complete aeration are calculated as follows:

Low Cost Estimate (High Efficiency Aerator)

6,489,179 kW-hr/year x $0.1685/kW-hr = $1,093,427/year

High Cost Estimate (Low Efficiency Aerator)

18,325,700 kW-hr/year x $0.1685/kW-hr = $3,087,880/year

As shown above, the estimated cost for only the electricity for a mechanically aeration to reduce ammonia emissions from an average size dairy in the Valley ranges from nearly $1.1 million per year to nearly $3.1 million per year. This cost does not include the design and construction of the mechanical aeration system or any additional operational costs. However, it is clear that the cost of electricity alone would make this system economically infeasible, especially when considering that the price of electricity is expected to continue to increase.

Although the NRCS Reference Guide states that surface aeration of manure is more common because of the difficulty and expense of complete mechanical aeration, the amount of oxygen provided by aeration of the surface of liquid manure would not be sufficient to oxidize ammonia. Any ammonia oxidized would be converted to nitrite and nitrate. Increased concentrations of nitrite and nitrate in the liquid manure may require treatment to protect water quality or increase emissions of NOx or nitrous oxide (N2O). Although surface aeration may sometimes reduce odors of some compounds, surface aeration may actually increase ammonia emissions because it accelerates the release of carbon dioxide (CO2), an acidic gas, which increases the pH of the manure promoting increased ammonia emissions.[111, 112] Additionally, low levels of aeration will not provide sufficient oxygen for treatment, but can increase the transfer of emissions from the manure to the air because of the increased disturbance at the surface of the liquid manure.

Naturally aerated lagoons are not feasible in the Valley because of the large land requirements, fully mechanically aerated lagoons are not practical because of the high energy requirements and costs, and surface aeration is not expected to reduce ammonia emissions; therefore, this is not a feasible measure to reduce ammonia emissions from liquid manure in the Valley.

The District is unaware of any instances in which oxygenation demonstrates to be a practical technology on any farm to decrease ammonia emissions from liquid manure and has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

[111] Zhao, B., Chen, S. (2003). Ammonia Volatilization from Dairy Manure under Anaerobic and Aerated Conditions at Different Temperature. Paper number 034148, 2003 American Society of Agricultural and Biological Engineers Annual Meeting. Retrieved from: https://elibrary.asabe.org/abstract.asp?aid=13892

[112] Kaffka, S., Barzee, T., El-Mashad, H., Williams, R., Zicari, S., Zhang, R. (2016). Evaluation of Dairy Manure Management Practices for Greenhouse Gas Emissions Mitigation in California. Final Technical Report to the State of California Air Resources Board Contract #14-456. Retrieved from: https://biomass.ucdavis.edu/wp-content/uploads/ARB-Report-Final-Draft-Transmittal-Feb-26-2016.pdf

Storage Bags - ***(applies to dairy cattle only)***

Manure storage bags have primarily been used to store manure from pig farms in Europe and Canada. They have also recently started to be used to store manure on some dairy farms that are relatively small compared to the typical dairies in the Valley. The storage of manure in bags is only suitable for small dairies that handle manure as a slurry. Manure storage bags are not suitable for large dairies that handle dilute liquid manure because of the large volumes of manure that must be stored until it can be applied to cropland. The majority of dairies in the Valley are large flush dairies in which liquid manure mixed with water is stored in large earthen lagoons or ponds until it can be applied to cropland. Dairies that handle manure as a slurry without the addition of water are extremely rare in the Valley. [113] In addition, lagoons and storage ponds that hold manure are required to be lined in order to reduce the chances of manure contaminating the groundwater. Manure storage bags may not be allowed because there is a high possibility that something may puncture the bag causing manure to leak, which could degrade groundwater.

The District is unaware of any dairies in the Valley that are currently using storage bags to store manure. Manure storage bags are not suitable for the typical size dairies in the Valley and there are questions about if these bags would comply with existing California regulations, including water regulations. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Liquid Manure Storage Covers - ***(applies to all CAFs)***

The NRCS Reference Guide includes manure storage covers as a potential measure to reduce emissions from the storage of manure. Manure can be handled and stored in the form of a thick slurry, a dilute liquid, or as a solid. A study[114] notes that placing a cover over a lagoon can reduce emissions, however the different cover types have both benefits and drawbacks. Such covers include, natural or synthetic and they may be flexible or rigid, which vary in cost. The type of cover that is appropriate for each operation depends on the size and type of manure storage, environmental factors, and the goals of the farm. Manure storage covers limit emissions by slowing diffusion of gases and reducing the effects of wind on the surface of the manure. Although manure storage covers may reduce pollutants directly emitted from the manure, they do not destroy or eliminate pollutants such as ammonia. Rather, concentrations of these pollutants increase in the stored manure and additional measures would be required to prevent their release when the manure is removed from storage.

[113] Marklein, A. R., Meyer, D., Fischer, M. L., Jeong, S., Rafiq, T., Carr, M., and Hopkins, F. M. (2021) Facility-Scale Inventory of Dairy Methane Emissions in California: Implications for Mitigation, Earth Syst. Sci. Data, 13, 1151–1166, https://doi.org/10.5194/essd-13-1151-2021, 2021.
[114] Marks, R. (2001). Cesspools of Shame: How Factory Farm Lagoons and Sprayfields Threaten Environmental and Public Health. *Natural Resources Defense Council and the Clean Water Network.* Retrieved from: https://www.nrdc.org/sites/default/files/cesspools.pdf

As previously mentioned, Valley dairies that handle manure as a slurry without the addition of water are extremely rare and therefore certain types of manure covers are generally not applicable. The NRCS Reference Guide notes that concrete covers cannot be used on earthen or steel manure storages and natural covers (e.g. straw, barely, cornstalks) are impractical if the surface area of the storage is very large. Dairies in the Valley primarily store liquid manure with low solids content in large earthen lagoons or ponds,[115] therefore concrete covers and natural covers cannot feasibly be used to cover liquid manure in the Valley. Additionally, the Valley regulations from the Regional Water Quality Control Board[116] and mosquito abatement districts[117] generally require the removal of any materials that would form natural covers in order to decrease the chances for the proliferation of mosquitos and other vectors.

Although covers made of rigid plastic, such as HDPE, may be a potential option to cover lagoons and ponds that store liquid manure in the Valley, they would be very prohibitively expensive because of the large area that would need to be covered. As previously mentioned, the average dairy in the Valley has almost 1,600 cows compared to a national average of less than 300 cows per dairy outside of California. Since the Valley dairies are larger compared to other dairies in the nation, the lagoons and ponds that store liquid manure are also several times larger compared to the national average dairy that stores mostly undiluted slurry manure.

Moreover, manure covers do not destroy ammonia, rather they create a barrier that suppresses emissions of ammonia from the manure and air space above the manure. This leads to increased concentrations of ammonia and other air contaminants in the manure and air space above the manure, which will just delay the release of ammonia until it is sent to a different pond or applied to land. The increase concentration of ammonia in the manure will also increase the pH and subsequently increase the potential for ammonia emissions. Furthermore, because of the warm climate of the Valley, covering a lagoon with a plastic cover would turn the lagoon into an anaerobic digester. The majority of anaerobic digesters operating on dairies in the Valley are already covered lagoon digesters. The NRCS Reference Guide also states that gases will build up under impermeable covers that must be flared or utilized in another way. Flaring or combusting these gases would produce NO_X, which is the primary precursor for PM2.5 in the Valley, as well as direct PM2.5 emissions.

The District has permitted several facilities to construct and operate a covered lagoon. However, in each case, the covered lagoon was part of a digester system to capture biogas/digester-gas, and the cost of the system was funded by grants from the California Department of Food and Agriculture (CDFA) Dairy Digester Research and Development Program.

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[115] Meyer, D., Price, P.L., Rossow, H.A., Silva-del-Rio, N., Karle, B., Robinson, P.H., DePeters, E.J., and Fadel, J. (2011) Survey of Dairy Housing and Manure Management Practices in California. Journal Dairy Sci. 94:4744-4750. https://doi.org/10.3168/jds.2010-3761
[116] California Regional Water Quality Control Board Central Valley Region. Order R5-2013-0122. Retrieved from: https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2013-0122.pdf
[117] The Fresno County Mosquito Control Districts. Retrieved from: https://fresnocountymosquito.org/

In conclusion, it is not reasonable to require covers to reduce ammonia emissions from liquid manure storage in the Valley given the high expense associated to the practice and the fact that the practice is not expected to result in any overall reductions of ammonia emissions in the Valley, but could increase emissions of other pollutants.

Solid Manure Storage Covers - *(applies to all CAFs)*

U.S. EPA identified Method 62 (Cover solid manure sources with sheeting) from the UK User Guide, noting that it could result in ammonia emission reductions up to 90 percent. Method 62 involves covering solid manure stores with sheeting, which provides a physical barrier preventing the release of ammonia to the air. U.S. EPA acknowledged that this method "would increase ammonium content of the slurry, potentially leading to higher ammonia emissions during storage and spreading." District Rule 4570, U.S. EPA acknowledges, contains mitigation measure options for the covering of dry manure piles, and in most cases, facilities are required to cover manure and separated solids or else remove them from the facility.[118]

Storage of solid manure/separated solids contributes a very small amount of total ammonia emissions in the Valley, by making up less than 2 percent of the total ammonia emissions from dairies. Nonetheless, covering for solid manure/separated solids during the months of October through May is included in Rule 4570 and required for most dairies during these 8 months of the year, which include the District's PM2.5 season.

Based on District permitting records covering solid manure or separated manure solids during October through May is required by 729 dairies, 84 percent of the dairies are subject to Rule 4570, and a larger percentage of the total dairy cattle since this measure is required for all dairies that are classified as large confined animal facilities under the rule.

Covers for solid manure/separated solids is not required during the summer because solid manure is primarily composed of organic material that is combustible and during the hot summers in the Valley, elevated temperatures increase the chances of spontaneous combustion of manure piles.[119] Therefore, for safety reasons manure covers cannot be required during the hotter summer months. However, through District Rule 4570, the District requires CAFs to cover solid manure/separated solids during the colder winter months, as shown below:

- Cover dry manure outside the housing with a weatherproof covering from October through May, except for times when wind events remove the covering, not to exceed 24 hours per event; and

[118] Chadwick, D.R. (2005). Emissions of Ammonia, Nitrous Oxide and Methane from Cattle Manure Heaps: Effect of Compaction and Covering. *Atmosphere Environment*, Vol. 39, Issue 4: 787-799. Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S135223100400994X

[119] Westendorf, M. L. "Animal Science Update: Spontaneous Combustion". New Jersey Farmer. August 15, 2016. Page 6. https://plant-pest-advisory.rutgers.edu/spontaneous-combustion/

- Cover separated solids outside the housing with a weatherproof covering from October through May, except for times when wind events remove the covering, not to exceed 24 hours per event.

In conclusion, the District already has a mechanism to implement this mitigation measure for solid manure/separated solid stored onsite. No additional ammonia reductions are expected from the suggested mitigation measure.

Allow Cattle Slurry Stores to Develop a Natural Crust - *(applies to dairy cattle only)*

This measure identified in the UK User Guide involves retaining a surface crust on slurry stores, composed of fiber and bedding material present in cattle slurry, for as long as possible. This practice is applicable to thick slurry manure, which differs from the typical liquid manure stored in the Valley. The dilute liquid manure handled in the Valley is stored in ponds and lagoons much larger than storages used for slurry manure in other regions, and does not contain enough solids to form a natural crust.

Additionally, this practice is more applicable to cooler climates, while in the Valley's warm climate, floating debris on liquid manure create a habitat for mosquitos and other vectors that carry diseases, including West Nile virus, zika, dengue, chikungunya, and St. Louis encephalitis.[120] To reduce the potential for the propagation of mosquitos and other disease carrying vectors, Regional Water Quality Control Board[121] and Mosquito Abatement District regulations require the removal of any dead algae, vegetation, and floating debris, including those that would form a natural crust on the surface of a lagoon or pond.[122] Thus, this practice is not allowed in the Valley. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Solid-Liquid Separation - *(applies to all CAFs)*

The NRCS Reference Guide states that for manure streams handled as a slurry, separation of the solid and liquid portions prior to storage, additional treatment, and/or land application may reduce odor and other gaseous emissions, particularly for undersized lagoons. Various solid separation technologies are used for these purposes, including screens, rotary drums, centrifugal tanks, earthen pits, weeping walls, settling basins and screw-presses.

Dairies in the Valley primarily handle liquid manure that has been diluted with water, rather than slurry manure, and the effluent from dairies in California often has a total

[120] The Fresno County Mosquito Control Districts. Retrieved from: https://fresnocountymosquito.org/

[121] California Regional Water Quality Control Board Central Valley Region. Order R5-2013-0122. Retrieved from: https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2013-0122.pdf

[122] Collar, C. (2005). West Nile Virus – How Dairies Can Help 'Fight the Bite. *University of California, Davis, Cooperative Extension.* Retrieved from: https://cemerced.ucanr.edu/newsletters/September_200523148.pdf

solids content of only 1 percent;[123] therefore this measure is not directly applicable to most dairies in the Valley. The NRCS Reference Guide indicates that solid-liquid separation does not work well for manure streams with very low or very high solids content, unless advanced technologies or multiple separation stages or screen sizes are used to remove large and small solids from the manure stream separately. These technologies will have additional challenges and increased costs. Additionally, some studies indicate that the majority of ammonia nitrogen in dilute manure streams remains in the liquid portion and are not removed by solid-liquid separation. The NRCS Reference Guide indicates that some separator designs may increase emissions of gases or particles during the separation process. Dried separated solids may also increase the potential for PM emissions.

As mentioned above, this control measure is applicable to manure handled as a slurry rather than the dilute liquid manure that is typically handled on dairies in the Valley. Therefore, this practice is not directly applicable to dairies in the Valley. However, for cattle facilities that handle liquid manure, Rule 4570 does allow the facilities to choose the option to remove solids from the waste system with a solid separator system prior to the waste entering the lagoon. This option has been chosen by the vast majority cattle facilities that handle liquid manure, including over 90 percent of dairy cattle facilities subject to Rule 4570.[124] The option in Rule 4570 is as follows:

- Remove solids from the waste system with a solid separator system, prior to the waste entering the lagoon.

In conclusion, the District already has a mitigation measure option to minimize emissions from solid-liquid manure separation. No additional ammonia reductions are expected from the suggested mitigation measure.

Anaerobic Digesters - ***(applies to dairy cattle only)***

Anaerobic digesters are storage or treatment lagoons that are undergoing anaerobic reactions, primarily located at dairies. Digesters are outfitted with roofs and covers that enclose all anaerobic emissions within the system and vent to a gas collection system that eliminates undesired methane emissions. The microbes performing anaerobic reactions in lagoons convert nitrogen to form various new compounds, including ammonia. Through the implementation of its Short-Lived Climate Pollutant Strategy and SB 1383,[125] the State of California has funded the installation of over 120 dairy digester

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[123] Meyer, D, Heguy, J., Karle, B. and Robinson, P. (2019) Characterize Physical and Chemical Properties of Manure in California Dairy Systems to Improve Greenhouse Gas Emission Estimates. California Environmental Protection Agency, Air Resources Board. Retrieved from: https://ww2.arb.ca.gov/sites/default/files/classic/research/apr/past/16rd002.pdf

[124] EPA-USDA NRCS. "Reference Guide for Poultry and Livestock Production Systems." September 2017. Retrieved from: https://www.epa.gov/sites/default/files/2017-01/documents/web_placeholder.pdf

[125] CARB. Analysis of Progress toward Achieving the 2030 Dairy and Livestock Sector Methane Emissions Target. (March 2022). Retrieved from: https://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=&ved=2ahUKEwiayMXd4af9AhXWrmoFHYf2BNsQFnoECBAQAQ&url=https%3A%2F%2Fww2.arb.ca.gov%2Fsites%2Fdefault%2Ffiles%2F2022-03%2Ffinal-dairy-livestock-SB1383-analysis.pdf&usg=AOvVaw32GB5_r8-3GsSd57-XTnyo

systems throughout the state to reduce methane emissions, with the majority of installations in the San Joaquin Valley. Through the generation of vehicle renewable natural gas, some dairy digester systems have the potential of reducing vehicle-related NOx, PM2.5, air toxics, and greenhouse gas (GHG) emissions.

Some forms of energy conversion from biogas (e.g., burning biogas in an engine to produce electricity) may increase emissions of NOx, a precursor for PM2.5 and ozone, and direct PM2.5 emissions. These emissions can have a negative impact in the Valley, which is designated as nonattainment for PM2.5 and ozone This technology is very expensive, due to capital costs, operation, and maintenance expenses. It also requires significant addition of water, and may not be feasible in water-limited areas.

The NRCS Reference Guide includes anaerobic digesters as a measure to reduce VOCs and GHG emissions, but does not indicate that it reduces ammonia. Some of the information discussed in the NRCS Reference Guide about anaerobic digestion indicates a potential for increased ammonia emissions. The results of some studies also indicate that there is a potential for increased ammonia emissions following digestion.[126] There is limited information regarding the potential and scale of ammonia emissions impacts associated with digester, and California does not currently attribute any increased ammonia impacts from the implementation of dairy digester systems.

At this time there are significant uncertainties about the overall effect of anaerobic digesters on ammonia emissions from manure and additional research is needed to better understand this, particularly for digesters in the Valley. Because of this and the very high costs associated with installation of anaerobic digesters, they are not a feasible option to implement into Rule 4570 at this time. However, this practice would be evaluated as a potential BACT measure for any new or expanding operations; the required mitigation measure from BACT Guideline 5.8.6[127], is as follows:

- Anaerobic treatment lagoon designed according to NRCS Guideline 359.

In conclusion, the District already has a mechanism to implement this mitigation measure for expanding or new confined animal facilities. No additional ammonia reductions are expected from the suggested mitigation measure.

<u>Manure Additives</u> - *(applies to all CAFs)*

Manure amendments are not practical for manure handled as a dilute liquid, which is typical for Valley dairies, because the large volume of water mixed with the manure greatly increases the amount of an amendment required to change the properties of liquid manure, such as pH. The addition of certain amendments also increases the risk

[126] Koirala, K., Ndegwa, P.M., Joo, H.S., Frear, C., Stockle, C.O., Harrison, J.H. (2013). Impact of Anaerobic Digestion of Liquid Dairy Manure on Ammonia Volatilization Process. *American Society of Agricultural and Biological Engineers,* Vol. 56(5): 1959-1966. Retrieved from: https://labs.wsu.edu/ndegwa/documents/2016/09/Article-57.pdf/
[127] CARB BACT Guidelines Tool. Retrieved from: https://ww2.arb.ca.gov/sites/default/files/classic/technology-clearinghouse/bact/BACTID781.pdf?:linktarget=_self&:embed=yes

of foaming in liquid manure, which can damage pumps.[128] For slurry and liquid manure, it is difficult and costly to apply a sufficient amount of amendments to change the pH of the manure because of its natural buffering capacity, or resistance to changes in pH due to its chemical properties.

The NRCS Reference Guide states, *"It is often difficult to establish microbiological additives due to competition from naturally-occurring bacteria in manure."* The microbes in microbial additives are often out-competed by the naturally occurring microorganisms, because of the abundance of diverse microorganisms that are naturally present in manure that can multiply rapidly when favorable conditions are present. As a result, microbial additives are often ineffective or must be continually added to the manure. A study[129] conducted by Iowa State University, clearly demonstrates that many questions remain unanswered about the general effectiveness of microbial additives used to reduce emissions. The study evaluated 12 commercial microbial additives that were marketed for their ability to reduce emissions of odorous VOCs, H2S, ammonia, GHG, and odors. The results indicated that emissions from the treated manure were not statistically significant to the untreated manure for any of the 12 products tested. Thus, the ability of microbial additives to reduce emissions from manure remains unproven. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Acidifying Slurry and Shifting Chemical Balance from Ammonia to Ammonium - *(applies to all CAFs)*

This mitigation method mentioned in the compilation by Guthrie, et al.[130] involves the use of manure amendments to minimize ammonia emissions. Manure amendments are not practical for manure handled as a dilute liquid, which is typical for Valley dairies, because the large volume of water mixed with the manure greatly increases the amount of an amendment required to change the properties of liquid manure, such as pH. The addition of certain amendments also increases the risk of foaming in liquid manure, which can damage pumps. For slurry and liquid manure, it is difficult and costly to apply a sufficient amount of amendments to change the pH of the manure because of natural buffering capacity. Notably, some additives can even increase emissions of certain pollutants and can be toxic to handle.

[128] USDA NRCS/EPA (2017) Agricultural Air Quality Conservation Measures Reference Guide for Poultry and Livestock Production Systems. https://www.nrcs.usda.gov/sites/default/files/2022-06/Ag_AQ_Conservation_Measures_Poultry_and_Livestock_September_2017.pdf

[129] Koziel, J., Chen, B., Andersen, D., Parker, D., Bialowiec, A., Banik, C., Lee, M., O'Brien, S., Ma, H., Meiirkhanuly, Z., Wi, J., Li, P., Iowa State University. (2021). Evaluating Manure Additives for Odor Mitigation. *National Hog Farmer.* Retrieved from: https://www.nationalhogfarmer.com/agenda/evaluating-manure-additives-odor-mitigation

[130] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). The Impact of Ammonia Emissions from Agriculture on Biodiversity. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html

Moreover, any additives to the manure require approval of the Regional Water Quality Control Board.[131] The Regional Water Quality Control Board has determined that increased salinity is a threat to water quality in the Valley.[132] As a result, in many cases the application of amendments and additives that use salts to change pH will not be allowed.

For reasons discussed above, manure amendments are not practical for most operations in the Valley. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Acidifying Amendments and Additives for Poultry Litter - ***(applies to poultry only)***

This method involves the application of aluminum to poultry litter to reduce the pH of the litter. However, poultry operations have already reduced nitrogen excretion by 55 percent and are not a significant source of ammonia in the Valley. Use of acidifying litter amendments is more common for poultry litter however, any additives to the manure require approval of the Regional Water Quality Control Board. The Regional Water Quality Control Board has determined that increased salinity is a threat to water quality in the Valley.[133, 134] As a result, in many cases the application of amendments and additives that use salts to change pH will not be allowed.

Notably, some additives can increase emissions of certain pollutants and can be toxic to handle. For example, the litter in poultry houses in the Valley are drier than many other parts of the country and therefore aluminum would need to be applied as a liquid. Nevertheless, liquid aluminum is an acid that is dangerous to handle and requires a certified applicator to be hired which results in higher costs.

Despite the uncertainties above, the District further evaluated the potential emission reductions of implementing this measure in the Valley. This analysis is provided below.

Ammonia is a weak base and reducing the pH of litter binds ammonia and reduces its volatilization. Aluminum sulfate, also known as alum, is a common compound used to treat poultry litter to reduce ammonia emissions and bind phosphorous to prevent runoff. The typical recommended application rate for aluminum sulfate is 0.1 to 0.2 lb of

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[131] California Regional Water Quality Control Board Central Valley Region. (March 2017). Resolution R5-2017-0031 (Accepting the Salt and Nitrate Management Plan). Retrieved from: https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/resolutions/r5-2017-0031_res.pdf
[132] California Regional Water Quality Control Board Central Valley Region. (May 2006). Salinity in the Central Valley. Retrieved from: https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/CDWA%20et%20al/SDWA_206.pdf
[133] California Regional Water Quality Control Board Central Valley Region. (May 2006). Salinity in the Central Valley. Retrieved from: https://www.waterboards.ca.gov/waterrights/water_issues/programs/bay_delta/california_waterfix/exhibits/docs/CDWA%20et%20al/SDWA_206.pdf
[134] California Regional Water Quality Control Board Central Valley Region. (March 2017). Resolution R5-2017-0031 (Accepting the Salt and Nitrate Management Plan). Retrieved from: https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/resolutions/r5-2017-0031_res.pdf

aluminum sulfate per broiler placed.[135] The higher the aluminum sulfate application rate, the higher the ammonia control and phosphorus binding ability of aluminum sulfate. The lower recommended application rate will control ammonia emissions for about half the time as the higher recommended application rate.[136, 137] Young chicks are more vulnerable to higher ammonia concentrations in the houses; however, ammonia emissions are lower because of the lower amount of manure produced by the smaller birds. These recommended application rates are based on broilers with a finished weight of approximately four pounds. Larger birds will require correspondingly larger application rates to achieve the same control of ammonia.[138]

A study published in 2020 found that an application rate of 98 kg of aluminum sulfate per 100 square meters incorporated into litter reduced overall ammonia emissions from broilers by 35 percent.[139] In the study, the birds were placed in 2.1 m by 1.8 m pens with 50 birds per pen to evaluate different treatments. Therefore, the application rate of alum on a per bird basis was calculated as follows:

98 kg/100 m^2 x 2.1 m × 1.8 m ÷ 50 bird = 0.074 kg/bird

The application rate of 0.074 kg/bird is equivalent to an application rate 0.16 lb-aluminum sulfate per bird. Therefore, it will be assumed that this is the application rate required to reduce ammonia emissions by 35 percent. The District's current ammonia emission factor for broiler chickens is 0.0958 lb-NH3/bird-year. Thus, the ammonia emission reductions for this practice can be calculated as follows:

0.0958 lb-NH3/bird-year x 35% = 0.0335 lb-NH3/bird/year

The cost of the emission reductions is based on the cost of the purchase and application of aluminum sulfate. Because of the typically dry conditions in the Valley, liquid aluminum sulfate is preferred because moisture is required for aluminum sulfate to react with ammonia. A USDA-ARS publication[140] indicates that one ton of aluminum sulfate is equivalent to 370 gallons of liquid aluminum sulfate. Based on a web search, the price of aluminum sulfate is estimated to be $1,155 per 55 gallon drum.[141] The customer applicator rate is assumed to be $100 for each broiler house housing 20,000

[135] See Moore, P. Treating Poultry Litter with Aluminum Sulfate. USDA ARS. Developed by Livestock GRACEnet. https://www.ars.usda.gov/ARSUserFiles/np212/LivestockGRACEnet/AlumPoultryLitter.pdf
[136] Moore, P., Watkins, S. Treating Poultry Litter with Alum. University of Arkansas (U of A) Division of Agriculture Cooperative Extension Service. https://www.uaex.uada.edu/publications/PDF/FSA-8003.pdf
[137] Moore, P., Miles, D., Burns, R. (March 2019). Reducing Ammonia Emissions from Poultry Litter with Alum. Livestock and Poultry Environmental Learning Community (LPELC). https://lpelc.org/reducing-ammonia-emissions-from-poultry-litter-with-alum/
[138] Anderson, K.; Moore, P.A., Jr.; Martin, J.; Ashworth, A.J. (2020) Effect of a New Manure Amendment on Ammonia Emissions from Poultry Litter. *Atmosphere*, *11*, 257. https://doi.org/10.3390/atmos11030257
[139] Penn, C., Zhang, H (April 2017) Alum-Treated Poultry Litter as a Fertilizer Source. Oklahoma State University Extension. https://extension.okstate.edu/fact-sheets/alum-treated-poultry-litter-as-a-fertilizer-source.html#nitrogen-content-of-alum-treated-litter
[140] See Moore, P. Treating Poultry Litter with Aluminum Sulfate. USDA ARS. Developed by Livestock GRACEnet. https://www.ars.usda.gov/ARSUserFiles/np212/LivestockGRACEnet/AlumPoultryLitter.pdf
[141] Alliance Chemical, Price of Aluminum Sulfate 50%. Retrieved from: https://alliancechemical.com/product/aluminum-sulfate-50/?attribute_pa_size=55-gallon&attribute_pa_packaging-type=drum&gclid=EAIaIQobChMIurHTv9WT_QIVMRPUAR1c5QvKEAQYASABEgJ5__D_BwE

birds. Therefore, the total cost for each application of aluminum sulfate on a per bird basis is calculated as follows:

0.16 lb-aluminum sulfate/bird x 1 ton/2,000 lb x 370 gal-aluminum sulfate/ton-aluminum sulfate x $1,155/55 gal-aluminum sulfate + $100/20,000 bird = $0.63/bird

Approximately 6.7 broiler flocks are produced each year and aluminum sulfate must be applied prior to placing each flock; therefore, the annual cost of this measure on a bird capacity basis is 6.7/year x $0.63/bird = $4.22/bird capacity-year.

The cost effectiveness of the ammonia reductions from this measure are calculated as follows:

$4.22/bird-year ÷ 0.0335 lb-NH3/bird-year x 2,000 lb/ton = $251,940/ton-NH3 reduced

As demonstrated above, the potential reductions from this measure are not cost effective, with a cost effectiveness of $251,940 per ton of ammonia reduced. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Urease Inhibitors - ***(applies to all cattle)***

A study[142] indicates that the information for this control measure was taken from AirControlNet, a software tool previously used by EPA to estimate the cost of emission reductions. The AirControlNET v.4.1 Documentation Report[143] indicates that the specific chemical additive that this measure refers to was N-(n-butyl) thiophosphoric triamide (NBPT), which was being sold under the trade name Conserve-Nr. NBPT is a type of urease inhibitor. The cost information was provided by a supplier of the chemical and appears to be an underestimate.

Urease inhibitors inhibit the action of the enzyme urease. Urease, which is present in feces and produced by soil microorganisms, converts urea into ammonia, which can then volatilize. Although there are many compounds that can inhibit urease, only a few are non-toxic, effective at low concentrations, and chemically stable. Urease inhibitors have shown promising results for reducing nitrogen emissions from urea-based fertilizers, but some studies indicate that there remain questions about their effectiveness in reducing ammonia from manure.[144]

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[142] Pinder, R., Adams, P., Pandis, S. (2007). Ammonia Emission Controls as a Cost-Effective Strategy for Reducing Atmospheric Particulate Matter in the Eastern United States. *Environmental Science and Technology*, Volume 41, Pages 380-386. Retrieved from: https://pubs.acs.org/doi/pdf/10.1021/es060379a
[143] E.H. Pechan & Associates, Inc. (September 2005). AirControlNET v.4.1 Documentation Report. Retrieved from: https://nepis.epa.gov/Exe/ZyPURL.cgi?Dockey=P1012ZYW.TXT
[144] Lasisi, A.A., Akinremi, O.O., and Kumaragamage, D. "Ammonia emission from manures treated with different rates of urease and nitrification inhibitors," Canadian Journal of Soil Science 100(3), 198-205, (25 February 2020). Retrieved from: https://doi.org/10.1139/cjss-2019-0128

Urease inhibitors appear to reduce ammonia emissions for relatively short periods of time and must be reapplied, and the buildup of urea in the pen surface may require that the NBPT additions increase with time to continue to control ammonia. Because of the need to re-apply increasing amounts of urease inhibitors as manure and urea accumulate, there will be increased costs.

Additionally, there is evidence that urease inhibitors may alter plant metabolism and lead to accumulation of urea in plant tissue,[145] which can have negative effects on crops. Urea inhibitors will also increase the amount of nitrogen in the manure, and to comply with Regional Water Quality Control Board Regulations, some farms would need to acquire additional cropland to apply the manure or identify ways to export the manure to ensure that nitrogen is not over-applied.

It appears that the treatment of animal manure with urease inhibitors has not yet been commercialized. This is likely because of the limited chemical stability of the inhibitors, the need for reapplication, the lack of efficient and automated application systems, and a subsequent increase in the cost for the farmer. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Surface Cooling of Slurry Manure - *(applies to all CAFs)*

The publication by Guthrie, et al.[146] suggests this measure for CAFs with a slurry manure handling system. The measure involves lowering the temperature of the slurry in the channels by pumping a coolant (e.g., groundwater) through a series of fins floating on the slurry. This measure appears to be largely theoretical, and the District is not aware of any instances in which cooling of liquid or slurry manure has been used to reduce emissions from animal production operations. Furthermore, there are high costs for installation of piping and pumping coolant and circulation of coolant through manure, and recycling groundwater may not be permitted in some regions. For these reasons, this measure is unproven and not feasible to implement in the Valley.

Feeding Strategies to Lower the pH of Manure - *(applies to all CAFs)*

Livestock feeding strategies can influence the pH of manure and urine. The pH of manure can be lowered by increasing the fermentation in the large intestine. This increases the volatile fatty acids (VFA) content of the manure and causes a lower pH. The pH of urine can be lowered by lowering the electrolyte balance of the diet. Furthermore, the pH of urine can be lowered by adding acidifying components to the diet. A low pH of the manure and urine excreted also results in a low pH of the slurry/manure during storage even after a certain storage period. This pH effect can

[145] Zanin L, Venuti S, Tomasi N, Zamboni A, De Brito Francisco RM, Varanini Z, Pinton R. (2016) Short-Term Treatment with the Urease Inhibitor N-(n-Butyl) Thiophosphoric Triamide (NBPT) Alters Urea Assimilation and Modulates Transcriptional Profiles of Genes Involved in Primary and Secondary Metabolism in Maize Seedlings. Front Plant Sci. 2016 Jun 22;7:845. doi: 10.3389/fpls.2016.00845. PMID: 27446099; PMCID: PMC4916206.

[146] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). The Impact of Ammonia Emissions from Agriculture on Biodiversity. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html

reduce ammonia emissions from slurries during storage and also following application. This measure is primarily for non-ruminants, such as poultry and pigs and is not recommended for cattle.

The pH of freshly excreted urine mainly depends on the electrolyte content of the diet. The pH of urine will eventually rise towards alkaline values due to the hydrolysis of urea irrespective of initial pH; however, the initial pH and the pH buffering capacity of urine affect the rate of ammonia volatilization from urine immediately following urination. Lowering the pH of urine of ruminants is theoretical possible. However, it has not been demonstrated to be feasible on actual farms. Lowering the pH of cattle manure is also theoretically possible, but this might easily coincide with disturbed rumen fermentation and is therefore not recommended. Since this measure has not been demonstrated for cattle and remains theoretical, it is premature to consider it as part of any regulatory efforts.

The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Land Application of Manure

Table 4-12 Land Application of Manure Measures Evaluated

Method	Measure	CAF Type	Reference
Timing of Land Application	Timing of Land Application	All Cattle	NRCS[147]
	Optimal Weather Conditions for Spreading	All Cattle	Guthrie[148]
Injection	Injection	All Cattle	NRCS
	Use Slurry Injection Application Techniques	All Cattle	Price[149]
	Injector	All Cattle	Guthrie
	Open-slot Injection	All Cattle	Webb[150]
	Injector	All Cattle	Eory[151]

[147] EPA-USDA NRCS. "Reference Guide for Poultry and Livestock Production Systems." September 2017. Retrieved from: https://www.epa.gov/sites/default/files/2017-01/documents/web_placeholder.pdf

[148] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). The Impact of Ammonia Emissions from Agriculture on Biodiversity. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html

[149] Price et al., "An Inventory of Mitigation Methods and Guide to their Effects on Diffuse Water Pollution, Greenhouse Gas Emissions and Ammonia Emissions from Agriculture, User Guide," December 2011. Retrieved from: https://repository.rothamsted.ac.uk/download/942687eab7ec4b83751c7e241d62f0fa8472d72adcd25a149bb891b7c30d55d0/1595300/MitigationMethods-UserGuideDecember2011FINAL.pdf

[150] Webb, J., Pain B., Bittman, S., Morgan J. The impacts of manure application methods on emissions of ammonia, nitrous oxide and on crop response—a review. Agric. Ecosyst. Environ. 137, 39–46 (2010). Retrieved from: https://www.sciencedirect.com/science/article/abs/pii/S0167880910000046?via%3Dihub

[151] Eory, V., Rees, B., Topp, K., Dewhurst, R., et al. ClimateXChange, "On-farm technologies for the reduction of greenhouse gas emissions in Scotland," March 2016. Retrieved from: https://www.climatexchange.org.uk/media/1927/on-farm_technology_report.pdf

Method	Measure	CAF Type	Reference
	Injection Techniques	All Cattle	Bittman[152]
	Injection into the Soil	All Cattle	Preece[153]
Incorporation of Liquid and Solid Manure	Incorporation	All Cattle	NRCS
	Incorporate Manure into the Soil	All Cattle	Price
	Incorporation of Manure	All Cattle	Guthrie
	Incorporation of Surface-Applied Solid Manure and Slurry into Soil	All Cattle	Bittman
	Incorporation into the Soil	All Cattle	Preece
	Incorporate Manure into the Soil	All Cattle	Atia[154]
	Immediate Incorporation of Applied Manure	All Cattle	Pinder[155]
Band Spreading	Banding	All Cattle	NRCS
	Slurry Band Spreading Application Techniques	All Cattle	Price
	Band Spreading	All Cattle	Guthrie
	Band Spreading Slurry	All Cattle	Bittman
Other Land Application	Slurry Dilution	All Cattle	Bittman
	Transport Manure to Neighboring Farms	All Cattle	Price

Timing of Land Application - ***(applies to all cattle)***

This measure requires operators to apply the correct amount of necessary nutrients to crops when they are most in demand and in locations where they can be accessed by specific plants. Applying nutrients in spring prior to planting, when crops are ready to utilize the nitrogen, can reduce ammonia emissions compared to applying in fall. Applying at lower soil temperatures can also help to reduce near-term ammonia emissions due to reduced microbial activity in cooler soils. Split application to better time the nutrient application to crop needs can also be beneficial.

Although not specifically included in Rule 4570, the measure is already required for confined animal facilities in the Valley that apply manure to land. Regional Water Quality Control Board Regulations[156] require that manure may only be applied to land at

[152] Bittman, S., Dedina, M., Howard C.M., Oenema, O., Sutton, M.A., (eds), 2014, "Options for Ammonia Mitigation: Guidance from the UNECE Task Force on Reactive Nitrogen," Centre for Ecology and Hydrology, Edinburgh, UK. Retrieved from: http://www.vuzt.cz/svt/vuzt/publ/P2014/037.pdf

[153] Preece, Sharon L.M. et al., ''Ammonia Emissions from Cattle Feeding Operations,'' Texas A&M AgriLife Extension Service, referring to Cole, N.A., R.N. Clark, R.W. Todd, C.R. Richardson, A. Gueye, L.W. Greene, and K. McBride, ''Influence of Dietary Crude Protein Concentration and Source on Potential Ammonia Emissions from Beef Cattle Manure,'' Journal of Animal Science 83:(3), 722 (2005)

[154] Atia, A. (2008). Ammonia volatilization from manure application. Alberta Agriculture, Food and Rural Development. Retrieved from: https://open.alberta.ca/dataset/b115d4b8-982d-43d5-97a6-1d987bf8ba01/resource/863253f1-22f1-4a7b-950a-c424ef5cc9e5/download/2008-538-3.pdf

[155] Pinder, R., Adams, P., Pandis, S. (2007). Ammonia Emission Controls as a Cost-Effective Strategy for Reducing Atmospheric Particulate Matter in the Eastern United States. *Environmental Science and Technology*, Volume 41, Pages 380-386. Retrieved from: https://pubs.acs.org/doi/pdf/10.1021/es060379a

[156] California Regional Water Quality Control Board Central Valley Region. Order R5-2013-0122. Retrieved from: https://www.waterboards.ca.gov/centralvalley/board_decisions/adopted_orders/general_orders/r5-2013-0122.pdf

agronomic rates in accordance with an approved nutrient management plan, and that nutrients, including nitrogen, may only be applied at times when plants can utilize these nutrients. The rate of application of manure and process wastewater for each crop in each land application area (also considering sources of nutrients other than manure or process wastewater) to meet each crop's needs without exceeding the application rates is specified in the Regional Water Quality Control Board Technical Standard.

The NRCS Reference Guide estimates that this measure will reduce ammonia emissions from land application by 65-70 percent. Because this measure is already required, as an industry standard, these reductions have already been achieved in the Valley.

Injection - *(applies to all cattle)*

Applying manure to the soil surface without incorporation can lead to significant emissions of ammonia and other odorous gases. Several of the mitigation measure compilations evaluated by the District included injection of liquid or slurry manure as an option to reduce ammonia emissions from land application. However, this method is more applicable to slurry manure than the dilute liquid manure applied to land in the Valley. Additionally, the equipment needed to transport and inject the dilute liquid manure, which is not typically used in the Valley, would have high costs for fuel and would increase emissions of NOx and PM2.5.

Estimated ammonia emissions reductions from the injection of liquid manure are based on the assumption that surface broadcasting of liquid manure is the typical practice. Broadcasting of liquid manure results in higher emissions because of the larger amount of surface area of the liquid manure that will be in direct contact with the atmosphere. However, nearly all liquid manure in the Valley is diluted and applied via surface gravity irrigation systems, such as flood and furrow irrigation. Because of the much lower concentration of ammonia in the diluted liquid manure typically applied in the Valley, and the reduced surface area of liquid manure in furrow and flood irrigation systems compared to broadcasting, ammonia emissions from the application of liquid manure in the Valley is already much lower than traditional surface broadcasting. A report prepared by the University of California Division of Agricultural and Natural Resources Committee of Experts on Dairy Manure Management[157] indicates that in California, "nearly all" manure from lagoons is diluted with irrigation water and applied via surface gravity irrigation systems and that "during irrigations, farmers commonly dilute lagoon water with 5 to 10 parts of fresh source water." The report goes on to state that "in systems with frequent, but well diluted manure water applications, ammonia losses from the ground surface will commonly be minimal during the irrigation (10 percent or less)."

[157] Chang, A., T. Harter, J. Letey, D. Meyer, R. D. Meyer, M. Campbell-Mathews, F. Mitloehner, S. Pettygrove, P. Robinson, R. Zhang (2006) Managing Dairy Manure in the Central Valley of California; University of California Committee of Experts on Dairy Manure Management Final Report to the Regional Water Quality Control Board, Region 5, Sacramento, June 2005. https://ucanr.edu/sites/groundwater/files/136450.pdf

The Ammonia Volatilization from Manure Application fact sheet,[158] estimates that ammonia losses from unincorporated manure to be 66 percent in the spring and early fall; this the standard practice in the Valley of applying manure by gravity flow irrigation is already estimated to reduce ammonia emissions by at least 85 percent compared to broadcasting of manure.

Furthermore, to avoid damaging growing crops, injection of liquid manure can only be performed prior to planting the crop, typically a maximum of two times per year. Additionally, the amount of nitrogen that can be applied to cropland is limited to protect water quality. Many agricultural areas in the Valley already have nitrate levels in the groundwater that are above acceptable limits, and many dairies are required to reduce the amount of nitrogen applied to land. Injection of manure reduces the amount of nitrogen emitted to the air, but the retained nitrogen is placed in the soil. Thus, injection of manure into the soil will increase the amount of nitrogen in the cropland and may not be feasible for some dairies, or will require additional land in order to comply with their nutrient management plans.

District Rule 4570 includes the requirement to minimize the amount of emissions from applying liquid manure to the soil. These mitigation measures include an option to inject liquid manure, as shown below:

- Apply liquid/slurry manure via injection with drag hose or similar apparatus.

In conclusion, the District already has mitigation measures for liquid manure injection. No additional ammonia reductions are expected from the suggested mitigation measures.

Incorporation of Liquid Manure - ***(applies to all cattle)***

Many mitigation measure compilations included incorporation of slurry and liquid manure into soil as an option to reduce ammonia emissions.[159] However, as discussed above, nearly all liquid manure in the Valley is diluted and applied via surface gravity irrigation systems, such as flood and furrow irrigation. Because of the of the much lower concentration of ammonia in the diluted liquid manure typically applied in the Valley, ammonia emissions from the application of liquid manure in the Valley is already much lower than the emissions from broadcasting slurry manure.

Slurry manure is not typically applied in the Valley and liquid manure in the Valley is diluted prior to application. However, District Rule 4570 includes a mitigation option to minimize the amount of emissions from incorporating liquid manure to the soil, as shown below:

[158] Atia, A. (2008). Ammonia volatilization from manure application. Alberta Agriculture, Food and Rural Development. Retrieved from: https://open.alberta.ca/dataset/b115d4b8-982d-43d5-97a6-1d987bf8ba01/resource/863253f1-22f1-4a7b-950a-c424ef5cc9e5/download/2008-538-3.pdf

[159] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). The Impact of Ammonia Emissions from Agriculture on Biodiversity. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html

- Allow liquid manure to stand in the fields for no more than 24 hours after irrigation.

In conclusion, the District already has mitigation measures for the incorporation of liquid manure. No additional ammonia reductions are expected from the suggested mitigation measures.

Incorporation of Solid Manure - *(applies to all cattle)*

The NRCS Reference Guide and UK User Guide include methods for incorporation of solid manure that involve mixing manure with surface soil to reduce the exposed surface area of the manure. The NRCS Reference Guide advises that incorporation should occur as soon as possible after the manure is applied, or at least within 24 hours, to reduce ammonia emissions. In the Valley, solid manure land application accounts for less than 3 percent of total ammonia emissions from dairies and incorporation of solid manure within 72 hours is already required for over 80 percent of cattle facilities that apply manure to land.

To avoid damaging growing crops, incorporation of solid manure can only be performed prior to planting the crop, typically a maximum of two times per year. Almost all dairies in the Valley use a double-crop farming system for their cropland to maximize the amount of manure that can be applied and increase the amount of feed produced for the cattle, with some dairies using a triple-crop system. In the typical double-crop system used on Valley dairies, corn for silage is planted in late April through June to be harvested in September, and winter forage (e.g. wheat, oats, barley, etc.) is planted in late September to be harvested in April or May.[160,161] Because of the very short time frame available between crops, the standard practice in the Valley is to incorporate applied solid manure as soon as practical so the land can be prepared for the next crop.

Solid manure applied to cropland is often incorporated immediately after application; however, additional time may sometimes be required due to unforeseen circumstances, such as difficult weather conditions, equipment breakdowns, or the unavailability of the contractors that perform the work since they may be busy at other farms that are also preparing to plant the next crop. With this under consideration, Rule 4570 gives additional time to account for the unforeseen circumstances that may unexpectedly delay incorporation of manure into cropland within 24 hours, as shown below:

- Incorporate all solid manure within 72 hours of land application.

[160] University of California, Davis. UC Drought Management – Corn. Retrieved from: https://ucmanagedrought.ucdavis.edu/Agriculture/Crop_Irrigation_Strategies/Corn/

[161] Ag Proud – Progressive Dairy. 12-Month Forage Pays. Retrieved from: https://www.agproud.com/articles/30676-12-month-forage-pays

The District is further evaluating requiring solid manure applied to cropland to be incorporated within 24 hours. An analysis of this measure, including the control efficiency and estimated costs, is below.

The control efficiency for incorporation is estimated based on information from the Chesapeake Bay Program Watershed Model report.[162] This report includes estimations of ammonia emission reductions for low-disturbance incorporation and high-disturbance incorporation of manure. The report gives vertical tillage as an example of low-disturbance incorporation and states that for high-disturbance incorporation, chisel plowing followed by secondary tillage with a disk harrow or field cultivator is expected to be the most common practice. Information in the report indicates that with low-disturbance incorporation, ammonia emissions are reduced 34 percent when manure is incorporated within 72 hours and 50 percent when manure is incorporated within 24 hours. The report also indicates that with high-disturbance incorporation, ammonia emissions are reduced 50 percent when manure is incorporated within 72 hours and 75 percent when manure is incorporated within 24 hours. Based on this information, the ammonia (NH3) emissions from incorporation of solid manure within 72 hours and 24 hours are estimated as follows:

<u>Low-Disturbance Incorporation of Solid Manure within 72 Hours</u>

Control Efficiency: 34%

Percent NH3 emissions of manure that is not incorporated: 66%

<u>Low-Disturbance Incorporation of Solid Manure within 24 Hours</u>

Control Efficiency: 50%

Percent NH3 emissions of manure that is not incorporated: 50%

<u>High-Disturbance Incorporation of Solid Manure within 72 Hours</u>

Control Efficiency: 50%

Percent NH3 emissions of manure that is not incorporated: 50%

<u>High-Disturbance Incorporation of Solid Manure within 24 Hours</u>

Control Efficiency: 75%

Percent NH3 emissions of manure that is not incorporated: 25%

[162] Chesapeake Bay Phase 6.0 Manure Incorporation And Injection Expert Review Panel: Dell, C., Allen, A., Dostie, D., Meinen, R., Maguire, R (December 2016) Manure Incorporation and Injection Practices for Use in Phase 6.0 of the Chesapeake Bay Program Watershed Model. Prepared for Chesapeake Bay Program, Annapolis, MD 21403. CBP/TRS-309-16. EPA Contract No. EP-C-12-055. https://d18lev1ok5leia.cloudfront.net/chesapeakebay/documents/phase_6_final_mii_final_report.pdf

The ammonia control efficiency for incorporation of solid manure within 24 hours rather than 72 hours, compared to the ammonia emissions from solid manure that is not incorporated is estimated as follows:

Low-Disturbance Incorporation of Solid Manure within 24 Hours

66% - 50% = 16%

High-Disturbance Incorporation of Solid Manure within 24 Hours

75% - 50% = 25%

The ammonia emissions from solid manure land application are approximately 2.8 percent of the ammonia emissions from dairies and other cattle facilities; therefore, the overall control efficiency of this measure is estimated to be:

Low-Disturbance Incorporation of Solid Manure within 24 Hours

17% x 2.8% = 0.48% of total NH3 emissions from cattle

High-Disturbance Incorporation of Solid Manure within 24 Hours

25% x 2.8% = 0.7% of total NH3 emissions from cattle

The incremental ammonia control efficiency for incorporation of solid manure within 24 hours compared to incorporation of solid manure within 72 hours is calculated as follows.

Low-Disturbance Incorporation of Solid Manure within 24 Hours

1 – (50%/66%) = 24.2%

High-Disturbance Incorporation of Solid Manure within 24 Hours

1 – (50%/75%) = 33.3%

This control efficiency is just for the application of solid manure to cropland, which is a very small portion of the total emissions from cattle facilities.

The cost of more rapid incorporation varies greatly, depending whether a farm already has the required equipment available or if the farm requires an additional tractor and must contract with a custom farm service to implement this practice. For farms for which the required equipment for more rapid incorporation is available, it will be assumed that the primary cost of this measure will be the additional labor required to operate the equipment, to ensure that the manure is incorporated within the required timeframe. For other farms for which the required equipment is not available, it will be assumed that they must hire a custom farm service to ensure that manure is incorporated within the required timeframe. The labor costs for incorporation of solid manure and the costs for hiring a custom farm service will be estimated based on information from the University of California Cooperative Extension.[163, 164] The costs for labor and hiring a custom farm service for low-disturbance incorporation of solid manure are assumed to be similar to finish discing of a field, and the costs for labor and hiring a custom farm service for high-disturbance incorporation of manure are assumed to be similar to chiseling a field followed by discing.

Based on the University of California Cooperative Extension publications, the incremental cost for low-disturbance incorporation of solid manure is estimated to be approximately $2.64 per acre if only additional labor is required, and $15.37 per acre if a custom farm service must be used. At dairies in the Valley, solid manure is typically applied to land twice per year so the overall cost for low-disturbance incorporation of solid manure is as follows:

<u>Incremental Labor Cost for Low-Disturbance Incorporation of Solid Manure within 24 Hours</u>

$2.64/acre x 2 time/year = $5.28/acre-year.

<u>Incremental Cost for Custom Farm Service for Low-Disturbance Incorporation of Solid Manure within 24 Hours</u>

$15.37/acre x 2 time/year = $30.74/acre-year.

Based on the University of California Cooperative Extension publications, the incremental cost for high-disturbance incorporation of solid manure is estimated to be approximately $6.60 per acre if only additional labor is required, and $64.21 per acre if a custom farm service must be used. As mentioned above, at dairies in the Valley solid manure is typically applied to land twice per year so the overall cost for high-disturbance incorporation of solid manure is as follows:

<u>Incremental Labor Cost for High-Disturbance Incorporation of Solid Manure within 24 Hours</u>

$6.60/acre x 2 time/year = $13.20/acre-year.

[163] University of California Cooperative Extension, Agriculture and Natural Resources, Agricultural Issues Center (2016) 2016 Sample Costs to Establish and Produce Alfalfa, Tulare County, Southern San Joaquin Valley, 300 Acre Planting. https://coststudyfiles.ucdavis.edu/uploads/cs_public/1c/e2/1ce256d0-957e-4bd4-b17e-18fef4efcedd/16alfalfasjv300acfinal_41916.pdf
[164] University of California Cooperative Extension, Agriculture and Natural Resources, Agricultural Issues Center (2016) 2016 Sample Costs to Establish and Produce Alfalfa, Tulare County, Southern San Joaquin Valley, 50 Acre Planting. https://coststudyfiles.ucdavis.edu/uploads/cs_public/24/b6/24b68b4a-4c04-4853-b127-d3461e1a248f/16alfalfasjv50ac_final_4192016.pdf

Incremental Cost for Custom Farm Service for High-Disturbance Incorporation of Solid Manure within 24 Hours

$64.21/acre x 2 time/year = $128.42/acre-year.

Estimated ammonia emissions from unincorporated manure will be based on measurements included in the 2008 Dairy Emission Study report by Schmidt.[165] Based on measurements in this study, ammonia emissions from unincorporated solid manure are estimated to be approximately 4 lb-NH3/acre-year.

The cost effectiveness of the potential ammonia reductions for low-disturbance incorporation of solid manure with 24 hours compared to incorporation with 72 hours are estimated as follows:

NH3 Emissions for Low-Disturbance Incorporation of Solid Manure within 72 hours:

4 lb-NH3/acre-year x 66% = 2.64 lb-NH3/acre-year

NH3 Emissions for Low-Disturbance Incorporation of Solid Manure within 24 hours:

4 lb-NH3/acre-year x 50% = 2.0 lb-NH3/acre-year

Potential NH3 Emission Reductions for Low-Disturbance Incorporation within 24 hours

= 2.64 lb-NH3/acre-year - 2.0 lb-NH3/acre-year = 0.64 lb-NH3/acre-year

Cost Effectiveness if Only Additional Labor is Required

Cost of NH3 reductions: $5.28/acre-year ÷ 0.64 lb-NH3/acre-year x 2,000 lb/ton = $16,500/ton-NH3

Cost Effectiveness if Custom Farm Service is Required

Cost of NH3 reductions: $30.74/acre-year ÷ 0.64 lb-NH3/acre-year x 2,000 lb/ton = $96,063/ton-NH3

The cost effectiveness of the potential ammonia reductions for high-disturbance incorporation of solid manure with 24 hours compared to incorporation with 72 hours are estimated as follows:

NH3 Emissions for High-Disturbance Incorporation of Solid Manure within 72 hours:

4 lb-NH3/acre-year x 50% = 2.0 lb-NH3/acre-year

[165] Schmidt, C., Card, T. (August 2009) 2008 Dairy Air Emissions Report: Summary of Dairy Emission Estimation Procedures. Prepared for the San Joaquin Valleywide Air Pollution Study Agency

<u>NH3 Emissions for High-Disturbance Incorporation of Solid Manure within 24 hours:</u>

4 lb-NH3/acre-year x 25% = 1.0 lb-NH3/acre-year

<u>Potential NH3 Emission Reductions for High-Disturbance Incorporation within 24 hours</u>

= 2.0 lb-NH3/acre-year - 1.0 lb-NH3/acre-year = 1.0 lb-NH3/acre-year

<u>Cost Effectiveness if Only Additional Labor is Required</u>

Cost of NH3 reductions: $13.20/acre-year ÷ 1.0 lb-NH3/acre-year x 2,000 lb/ton = $26,400/ton-NH3

<u>Cost Effectiveness if Custom Farm Service is Required</u>

Cost of NH3 reductions: $128.42/acre-year ÷ 1.0 lb-NH3/acre-year x 2,000 lb/ton = $256,840/ton-NH3

As explained above, cattle facilities that apply solid manure to cropland incorporate the manure as quickly as possible in order to prepare for planting of the next crop; so this is already an industry standard, therefore, many cattle facilities are already attaining the potential ammonia emission reductions of this practice, except when conditions make this impractical.

In conclusion, the District already has mitigation measures for incorporation of solid manure. No additional ammonia reductions are expected from the suggested mitigation measures.

<u>Band Spreading</u> - *(applies to all cattle)*

This practice[166] reduces volatilization of ammonia by using low-pressure application near the ground. Band spreading of manure can only be done during very limited periods immediately prior to planting of a crop, a maximum of two times per year. This practice is primarily applicable to slurry manure rather than flush manure, and has limited applicability to the Valley in which most manure is applied as a liquid or a solid. Band spreading is generally a slower operation (with lower application rates), so there may be some issues with labor availability. Additionally, there are high costs due to the initial investment of new machines, as well as the costs of ongoing maintenance and fuel.

As previously discussed, nearly all liquid manure in the Valley is diluted and applied via surface gravity irrigation systems, such as flood and furrow irrigation, which allows

[166] Chang, A., T. Harter, J. Letey, D. Meyer, R. D. Meyer, M. Campbell-Mathews, F. Mitloehner, S. Pettygrove, P. Robinson, R. Zhang (2006) Managing Dairy Manure in the Central Valley of California; University of California Committee of Experts on Dairy Manure Management Final Report to the Regional Water Quality Control Board, Region 5, Sacramento, June 2005. https://ucanr.edu/sites/groundwater/files/136450.pdf

manure to flow on the ground without using pressure to apply liquid manure. Due to the much lower concentration of ammonia in the diluted liquid manure typically applied in the Valley, and the reduced surface area of liquid manure in furrow and flood irrigation systems compared to broadcasting, ammonia emissions from the application of liquid manure in the Valley is already much lower than traditional surface broadcasting and also expected to be lower than emissions from liquid manure applied with band spreading. Moreover, trucks used for these methods would damage growing crops and directly emit NOx and PM, hindering the District's efforts to attain the PM2.5 and ozone NAAQS. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Slurry Dilution - *(applies to all cattle)*

This method involves the dilution of slurry with water to decrease the ammonium-N concentration, as well as increase the rate of infiltration into the soil following spreading on land. For undiluted slurry, dilution must be at least 1:1 (one part slurry to one part water) to reduce emissions by at least 30 percent.

This practice is applicable to manure handled as a slurry. The slurry manure would be diluted by 50 percent so it can be infiltrated into soil more quickly. The ammonia reductions for this measure are proportional to the extent of dilution. The majority of dairies in the Valley are large flush dairies in which liquid manure mixed with water is stored in large earthen lagoons or ponds until it can be applied to cropland. The typical practice in the Valley is to dilute manure with irrigation water when it is applied to cropland. The liquid handled on Valley dairies typically has a DM content of 2 percent or less. This manure is then commonly further diluted with 5 to 10 parts of fresh source water during irrigation. Because of this, ammonia emissions from the typical application of liquid manure can be estimated to be more than 90 percent lower than the ammonia emissions from this practice (4.5 percent DM applied, compared to 0.2 percent DM applied). The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Transport Manure to Neighboring Farms - *(applies to all cattle)*

This mitigation measure does not result in overall decreases in ammonia emissions. Although ammonia emissions are reduced from the exporting farm, these emissions are transferred to the receiving farm.

Regional Water Quality Control Board Regulations prohibit the over-application of nutrients from manure in the Valley and already only allow manure to be applied at agronomic rates in accordance with an approved nutrient or waste management plan. Nutrient management plans require that farms transport excess manure to other fields or identify other uses for excess manure. Transporting manure would increase emissions of NOx and PM2.5 from fuel use, and these emissions would hinder the District's efforts to attain the PM2.5 and ozone NAAQS. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Other Mitigation Measures

Table 4-13 Other Mitigation Measures Evaluated

Method	Measure	CAF Type	Reference
Other	Pasture and Range Management: Stocking Density	Other Cattle	NRCS[167]
	Improved Livestock Genetics	All	Price[168]
	Planting a Tree Shelter Belt	All	Guthrie[169]
	Using Plants with Improved Nitrogen Use Efficiency	All Cattle	Guthrie
	Changing Land from Arable to Woodland	All	Guthrie
	Reduced Consumption of Meat and Eggs by Humans	All	Guthrie

Pasture and Range Management: Stocking Density - ***(applies to grazing cattle only)***

The NRCS Reference Guide lists managing animal stocking density at grazing-based livestock operations as a mitigation method for ammonia emissions. However, the District does not have authority to regulate animals on pasture or rangeland, as they are not confined. This measure also does not recommend a specific stocking density; however, cattle that graze on pastureland and rangeland in California generally require low stocking densities to provide sufficient forage for cattle. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Improved Genetics - ***(applies to all CAFs)***

A publication prepared for use in the United Kingdom includes genetic selection of useful traits to improve animal health and fertility as a potential mitigation measure to increase the efficiency of animals and reduce environmental impacts. Farmers select animal breeds that have improved genetics that increase efficiency as feasible to reduce overall costs and increase yield. The publication notes that use of animals with improved genetics "*is generally good in the poultry, dairy and pig industries*." Improvements in genetics and management practices to increase efficiency have already significantly reduced the environmental footprint of production from animal agriculture compared to previous years. As a result of genetic selection and improved

[167] EPA-USDA NRCS. "Reference Guide for Poultry and Livestock Production Systems." September 2017. Retrieved from: https://www.epa.gov/sites/default/files/2017-01/documents/web_placeholder.pdf
[168] Price et al., "An Inventory of Mitigation Methods and Guide to their Effects on Diffuse Water Pollution, Greenhouse Gas Emissions and Ammonia Emissions from Agriculture, User Guide," December 2011. Retrieved from: https://repository.rothamsted.ac.uk/download/942687eab7ec4b83751c7e241d62f0fa8472d72adcd25a149bb891b7c30d55d0/1595300/MitigationMethods-UserGuideDecember2011FINAL.pdf
[169] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). The Impact of Ammonia Emissions from Agriculture on Biodiversity. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html

diets, milk production per cow has increased and feed usage has decreased by 77 percent and water use has decreased by 65 percent.[170] GHG emissions from California dairy cattle per amount of milk produced have also decreased by over 45 percent in the 50 years from 1964 to 2014.[171] For poultry, it is estimated that genetic selection and the current feed practices have reduced nitrogen excretion by poultry by up to 55 percent, primarily due to the reduced time from egg to market age.[172]

Farmers are expected to continue to use animals with improved genetics that will increase efficiency and reduce production costs. However, there are several issues that cause this measure to be unsuitable as a requirement in a regulation. The study does not specify the genetic traits that need to be improved. The measure is largely theoretical and requires extensive research and funding to develop new breeds with the desired traits. It would take generations of each breed to evaluate the effectiveness of the breeds as it pertains to reducing ammonia emissions and any potential adverse impacts on the environment. There are also potential ethical concerns regarding if animals were to be genetically modified to accelerate selection of specific traits. Therefore, the District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Planting a Tree Shelter Belt - ***(applies to all CAFs)***

This measure involves planting tree shelterbelts around livestock housing and manure slurry storage facilities to disrupt airflow around these sites. The effectiveness of tree shelterbelts as a measure to reduce particulate matter from facilities depends on the shelterbelt height, canopy density, and the prevailing environmental conditions. While some evidence demonstrates effectiveness for PM2.5 emissions reductions, there is little to no evidence for ammonia emissions reductions. Effective tree shelterbelts are expensive and difficult to establish due to the large size of the facilities, severe water limitations, soil conditions, and the number of trees needed to protect these areas.

Irrespective of the lack of available data on the potential ammonia emissions reductions, implementation of this measure requires additional consideration with respect to animal health. Cattle facilities in the Valley depend on natural airflow to cool cattle and provide them with fresh air. Disrupting natural airflow can adversely affect cattle that depend on the natural flow of air, particularly during summer months where large numbers of heat-related animal mortalities occur in the San Joaquin Valley. Tree shelterbelts also require sufficient space to be effective, thus, dairies would need either to remove crops or acquire additional land for a shelterbelt. Furthermore, a shelterbelt of sufficient height to

[170] McCabe, C. (2021). How Dairy Milk Has Improved its Environmental and Climate Impact. Clarity and Leadership for Environmental Awareness and Research at UC Davis. Retrieved from: https://clear.ucdavis.edu/explainers/how-dairy-milk-has-improved-its-environmental-and-climate-impact

[171] Naranjo A., Johnson A., Rossow H., Kebreab E. (2020) Greenhouse Gas, Water, and Land Footprint per Unit of Production of the California Dairy Industry Over 50 years. J Dairy Sci. 2020 Apr;103(4):3760-3773. doi: 10.3168/jds.2019-16576. Epub 2020 Feb 7. PMID: 32037166.

[172] United States Department of Agriculture - Natural Resources Conservation Service. (2020). Feed and Animal Management for Poultry. Nutrient Management Technical Note No. 190-NM-4. Retrieved from: https://directives.sc.egov.usda.gov/OpenNonWebContent.aspx?content=45569.wba

be effective would take a number of years to establish. In many cases in the Valley, where the soil has high salinity, conditions are unsuitable for planting tree shelterbelts.

In several cases, permitted CAFs proposed to grow shelterbelts to satisfy District BACT requirements, however, the shelterbelts were not sustainable. Agronomic land surveys of the facilities confirmed the poor soil quality would not sustain the tree shelterbelts. As a result, the District eliminated this option as a BACT requirement for these specific CAFs and allowed an alternative mitigation measure to be implemented.

For the reasons listed above, it is infeasible to require planting tree shelterbelts at animal facilities; however, the trees and plants in the agricultural fields and orchards that surround Valley animal facilities already capture a portion of emissions from these facilities and remove some of the ammonia by deposition. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Using Plants with Improved Nitrogen Use Efficiency - ***(applies to all cattle)***

This measure involves developing new plant varieties with improved genetic traits for the capture of soil nitrogen, which would allow reduced fertilizer application. New plant varieties could also be developed with improved nutritional characteristics. This measure is theoretical and requires extensive research and funding to develop new plant varieties with the desired traits. Years of testing would be required to evaluate the effectiveness of new plant varieties for reducing ammonia emissions and any adverse impacts of the new plant varieties. Furthermore, capturing additional soil nitrogen would primarily benefit water quality rather than reducing ammonia emissions. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Changing Land Use from Arable to Woodland - ***(applies to all CAFs)***

This measure involves changing land use from agricultural land to permanent woodland. However, many areas in the Valley are dry and often affected by droughts, and thus not suitable for the establishment of permanent woodlands. The District does not have authority to require that agricultural land be converted to forests. Moreover, conversion of agricultural land to farmland would result in total loss of income for the farmers and an associated loss in tax revenue. The District has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Reduced consumption of meat and eggs by humans by 63 percent - ***(applies to all CAFs)***

The District does not have authority to regulate what people eat and has concluded that the measure discussed is not a viable mitigation option to include in Rule 4570.

Evaluation of Potential Emissions Reductions from CAFs

As demonstrated in the evaluation above, the District has only identified a few measures that have the theoretical potential to reduce additional ammonia emissions beyond the practices currently enforced through Rule 4570. These measures are reducing CP content in feed for beef finishing cattle, incorporation of solid manure within 24 hours, and acidifying amendments for poultry litter and manure. Despite the technological and economic feasibility issues of these mitigation measures, the District evaluated the potential emission reductions and the impact they might have on the Valley's total ammonia emissions inventory if these measures were to be implemented. This was calculated as follows.

- Control efficiency of reducing CP content in feed for beef finishing cattle, applied to beef cattle emissions inventory:

  18.9% x 16.2 tpd = 3.1 tpd

- Control efficiency of incorporation of solid manure within 24 hours, applied to beef and dairy cattle emissions inventory:

  0.48% x 141.5 tpd = 0.7 tpd

- Control efficiency of acidifying amendments for poultry litter and manure, applied to broiler and layer emissions inventory:

  35% x 7.8 tpd = 2.7 tpd

The emissions reductions from the measures above total 6.5 tpd, which would be reduced from the total ammonia emissions inventory of 306.5 tpd:

6.5 tpd ÷ 306.5 tpd = 2.1%

Overall, ammonia emissions from CAFs in the Valley can only be reduced by 2 percent by implementing the mitigation measures above. This demonstrates that additional reductions in the EPA-recommended range of 30-70 percent are infeasible.

Fertilizers

Ammonia emissions from agricultural fertilizers are 109.9 in 2030. Emissions growth from agricultural fertilizers are estimated by farmland acreage projection data developed by the Farmland Mapping & Monitoring Program (FMMP) of the California Department of Conservation.

The California Department of Food and Agriculture (CDFA) Feed, Fertilizer and Livestock Drugs Regulatory Services (FFLDRS) Branch primary focus is to ensure in every way possible a clean and wholesome supply of meat and milk, and to promote environmentally safe and agronomically sound use and handling of fertilizer materials. This is performed through regulating manufacturing, labeling, and use of fertilizing materials, feed and livestock drugs.

The CDFA Fertilizer Research and Education Program (FREP) funds and facilitates research to advance the environmentally safe and agronomically sound use and handling of fertilizing materials. FREP is voluntary and serves growers, agricultural supply and service professionals, extension personnel, public agencies, consultants, and other interested parties.

The Fertilizer Inspection Advisory Board (FIAB) is a statutory body that is advisory to the CDFA secretary on matters pertaining to fertilizer issues, including FREP activities. The Board consists of nine persons appointed by the secretary of agriculture, one of whom shall be a public member and eight of whom shall be licensed with CDFA to manufacture or distribute fertilizing materials, including organic inputs. The FIAB established the Technical Advisory Subcommittee (TASC) to advise the FIAB on matters related to the funding of FREP projects. The TASC serves as an expert scientific panel on matters concerning plant nutrition and on environmental effects related to fertilizing materials use. TASC assists in setting research priorities, reviews research proposals, and makes recommendations on projects for funding.

The composition of the TASC is determined by the FIAB. There should be at least nine members representing the major segments of the fertilizer industry, certified crop advisors, technical experts, farming community, public, and governmental agencies. Members have to demonstrate knowledge, technical and scientific expertise in the fields of fertilizing materials, agronomy, plant physiology, principles of experimental research, production agriculture, and environmental issues related to fertilizing materials use. One member can satisfy more than one of the criteria stated above. At minimum, one member shall be appointed from the membership of the FIAB, and one member on the TASC shall be from CDFA.

The TASC meets at least two times per year-once in spring to evaluate concept proposals and once in summer to evaluate full proposals. Additional meetings are necessary for special initiatives. Meetings typically last all day and alternate between Sacramento and other locations throughout the State. Serving on the TASC requires a time commitment in addition to participating in meetings. Members must read and critically evaluate all concept proposals (typically around 35 two-page proposals) and full proposals (typically at least ten 15-page proposals). In addition, TASC members are responsible for reviewing final research reports for FREP funded projects and may be asked to participate in conferences and special initiatives.

CARB has not found an ammonia emission reduction measure for fertilizers that meets U.S. EPA requirements for SIP submittal. CARB staff reached out to the National Association of Clean Air Agencies (NACAA) to ascertain whether other air pollution control agencies across the United States had any experience or regulations reducing ammonia emissions from fertilizers. NACAA reached out to all of their members and CARB staff did not receive any existing rules or regulations controlling ammonia emissions from fertilizers. CARB staff also reached out to EPA Region 9 staff whether they were aware of any rules or regulations controlling ammonia emissions from fertilizers and they were not aware of any. EPA Region 9 staff did ask CARB to review some practices per Table 4-14.

Mitigation Measures

Table 4-14 Fertilizer Mitigation Measures Evaluated

Method	Measure	Reference
Fertilizer	Optimizing or minimizing use of fertilizer	Guthrie
	Adding a Urease Inhibitor	Guthrie
	Mixing and injecting fertilizer into the soil quickly	Guthrie and Eory
	Applying fertilizer during optimal weather conditions	Guthrie and Eory

Optimize or minimize use of fertilizer

The San Joaquin Valley is a part of Central Valley Water Board of the California Water Board, which is an expansive region extending south from the Oregon border to the northernmost portion of Los Angeles County. The California Legislature passed Senate Bill 390 in 1999, which required Water Boards to develop programs that regulate agricultural lands in accordance with the Porter-Cologne Water Quality Control Act (California Water Code Division 7). In 2003, the Central Valley Irrigated Lands Regulatory Program (ILRP) was established, regulating agricultural discharges to surface waters. The Central Valley Water Board extended the regulations in 2012 to include discharges to ground waters. With the exclusion of lands that are never-irrigated or are covered under a separate Central Valley Water Board program, all commercial irrigated lands are required to obtain regulatory coverage under the ILRP.[173] In accordance with the ILRP, growers are required to prepare farm management plans – which includes an Irrigation Nitrogen Management Plan Summary Report – that comply with the approved upon Waste Discharge Requirements (WDR). Using information from the Reports, inferences can be made about nitrogen management based on estimates that compare nitrogen applied (A) to the nitrogen removed (R) from a field: A/R ratio and A-R difference. Included in the nitrogen fraction is any nitrogen proactively added to a field such as organic amendments, synthetic fertilizers, manure, and irrigation water, whereas nitrogen removed refers to the nitrogen in the materials removed from the field.[174]

Though growers do not have an immediate requirement under ILRP to use nitrogen efficient strategies, growers that are deemed outliers in A/R ratio and A-R difference would be required to employ enhanced strategies to lower these estimates. CDFA

[173] Central Valley Water Board. *Irrigated Lands Regulatory Program (ILRP) FAQs*. Available at: https://www.waterboards.ca.gov/centralvalley/water_issues/irrigated_lands/ilrp_faq.pdf
[174] California State Water Resources Control Board. *State of California State Water Resources Control Board, Order WQ 2018-0002.* Available at: https://www.waterboards.ca.gov/board_decisions/adopted_orders/water_quality/2018/wqo2018_0002_with_data_fig1_2_appendix_a.pdf

FREP offers an Irrigation and Nitrogen Management training program[175] for this purpose among others. A subset of the Irrigation and Nitrogen Management training program is dedicated to nitrogen efficiency, including overviews of the “4 R’s” of nitrogen management, and of efficient nitrogen practices.[176] The 4 R’s principles are founded on applying the “Right source” of nitrogen at the “Right rate”, “Right time”, and “Right place”. The right rate principle is with the identified measure, as it promotes strategies for providing nitrogen in rates that do not go beyond the crop demand for nitrogen. Examples of how this can be accomplished include adjusting the rate of application based on expected crop yield and adjusting season application rates based on soil and plant-tissue testing.

Guthrie et al. (2018) describe how minimizing the amount of fertilizer applied to an level that is optimal for crop can reduce ammonia emissions.[177] This measure and associated findings were not well described by both Guthrie et al. (2018) and the publications they referenced, nor were any specific regulations identified.[178,179,180,181] Additionally, the viewpoints of Guthrie et al. (2018) were prepared in the context of Europe and United Kingdom. There is therefore a probability that the conditions and farming practices described by Guthrie et al. (2018) are consistent with those present and employed in California. This, combined with the lack in strong evidence demonstrating the emission reduction potentials, demonstrates the need for additional research be completed under conditions consistent with those of the San Joaquin valley before this measure can be considered.

Urease Inhibitor

When combined with urease enzyme present in plants, urea present in urea-based fertilizers can be converted into ammonia, which can then volatilize. Urease inhibitors are a class of nitrogen stabilizer designed to minimize volatilization from applied nitrogen sources by inhibiting the action of the urease, thereby reducing the formation of ammonia.

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[175] CDFA. *Fertilizer Research and Education Program*. Available at: https://www.cdfa.ca.gov/is/ffldrs/frep/

[176] CDFA. *Irrigation and Nitrogen Management Training for Grower Self-Certification*. Available at: https://www.cdfa.ca.gov/is/ffldrs/frep/pdfs/training/inmtp_workbook.pdf

[177] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). Impact of ammonia emissions from agriculture on biodiversity: An evidence synthesis. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html

[178] UNECE. 2015. United Nations Economic Commission for Europe Framework Code for Good Agricultural Practice for Reducing Ammonia Emissions. United Nations Economic Commission for Europe Convention on Long-range Transboundary Air Pollution. https://unece.org/environment-policy/publications/framework-code-good-agricultural-practice-reducing-ammonia

[179] Zhang, Y., A.L. Collins, J.I. Jones, P.J. Johnes, A. Inman, J.E. Freer. (2017). The potential benefits of on-farm mitigation scenarios for reducing multiple pollutant loadings in prioritised agri-environment areas across England. Environmental Science & Policy 73, 100-114. https://doi.org/10.1016/j.envsci.2017.04.004

[180] Collins, A.L., Y.S. Zhang, M. Winter, A. Inman, J.I. Jones, P.J. Johnes, W. Cleasby, E. Vrain, A. Lovett, L. Noble. (2016). Tackling agricultural diffuse pollution: What might uptake of farmer-preferred measures deliver for emissions to water and air? Science of The Total Environment 547, 269-281. https://doi.org/10.1016/j.scitotenv.2015.12.130

[181] Dalgaard, T., J. F. Bienkowski, A. Bleeker, U. Dragosits, J. L. Drouet, P. Durand, A. Frumau, N. J. Hutchings, A. Kedziora, V. Magliulo, J. E. Olesen, M. R. Theobald, O. Maury, N. Akkal, P. Cellier. (2012). Farm nitrogen balances in six European landscapes as an indicator for nitrogen losses and basis for improved management. Biogeosciences 9, 5303–5321. https://doi.org/10.5194/bg-9-5303-2012

Nitrogen stabilizers are regulated by federal and State regulatory agencies. At the federal level, The Federal Insecticide, Fungicide, and Rodenticide Act requires that nitrogen stabilizers sold and distributed in the United States be registered with U.S. EPA.[182] At the state level, both the California Department of Pesticide Regulations (DPR) and CDFA maintain regulatory authorities over nitrogen stabilizers. While DPR requires all nitrogen stabilizers to be registered,[183] CDFA regulates licensing, registration, labeling, tonnage reporting, and inspection of only a subset of commercial nitrogen stabilizers.[184] In coordination with 4R Nutrient Stewardship and UC Davis Land and Water Resources, CDFA FREP also encourage growers to use enhanced-efficiency sources such as Urease Inhibitors, identifying these sources as possible "Right Source" through their 4 R's principles.[185]

Although urease inhibitors have shown tremendous promise in reducing ammonia emissions, some studies indicate potential occurrences of pollution swapping through increasing of NOx emissions which must be critically considered and explored prior to further considering the measure.[186,187] Additionally, although there are numerous identified benefits associated with the use urease inhibitors, there is little existing knowledge about their potential to enter the food chain and impact food safety.[188] Further research is needed which demonstrates that there are no food safety-related issues prior to this measure being viable for consideration.

According to Guthrie et al. (2018), the addition of a urease inhibitor has the potential to reduce ammonia emissions by 40-70 percent.[189] Though this has the potential to hold remarkable mitigation potential, their estimates along with those of the original experiments, were prepared under European and United Kingdom conditions. As these findings were based outside of California where environmental and climatic conditions may differ, further research is needed that explores the reduction potentials of urease inhibitors in conditions consistent with those of the San Joaquin Valley. In addition to

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[182] US EPA. *Nitrogen Stabilizer Products that Must Be Registered under FIFRA*. Available at: https://www.epa.gov/pesticide-registration/nitrogen-stabilizer-products-must-be-registered-under-fifra

[183] CDPR. *A Guide to Pesticide Regulation in California 2017 Update*. Available at: https://www.cdpr.ca.gov/docs/pressrls/dprguide/dprguide.pdf

[184] CDFA. *California Fertilizer Laws and Regulations*. Available at: https://www.cdfa.ca.gov/is/docs/Fertilizer_Law_and_Regs.pdf

[185] CDFA FREP. *California Crop Fertilization Guidelines.* Available at: https://www.cdfa.ca.gov/is/ffldrs/frep/FertilizationGuidelines/Adjustments.html#h11

[186] Drury, C.F., X. Yang, W.D. Reynolds, W. Calder, T.O. Oloya, A.L. Woodley. (2017). Combining Urease and Nitrification Inhibitors with Incorporation Reduces Ammonia and Nitrous Oxide Emissions and Increases Corn Yields. Journal of Environmental Quality 46:5, 939-949. https://doi.org/10.2134/jeq2017.03.0106

[187] Mirkhani, R., C. Resch, G. Weltin, L. K. Heng, J. Mitchell, R. Clare Hood-Nowotny, G. Dercon. (2023). Effect of urease inhibitor and biofertilizer on nitrous oxide emission, EGU General Assembly 2023, Vienna, Austria, 24–28 Apr 2023, EGU23-11242, https://doi.org/10.5194/egusphere-egu23-11242

[188] Byrne M.P., J.T. Tobin, P.J. Forrestal, M. Danaher, C.G. Nkwonta, K. Richards, E. Cummins, S.A. Hogan, T.F. O'Callaghan. (2020). Urease and Nitrification Inhibitors—As Mitigation Tools for Greenhouse Gas Emissions in Sustainable Dairy Systems: A Review. Sustainability 12:15, 6018. https://doi.org/10.3390/su12156018

[189] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). Impact of ammonia emissions from agriculture on biodiversity: An evidence synthesis. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html

this, Guthrie et al. (2018) merely identified the measures but did not reference or identify any specific regulations.

Quick mixing and injecting into soil

The identified measure would involve rapid incorporation of fertilizers into soils after the fertilizers have been applied. As previously described, with the implementation of ILRP and WDRs by the Central Valley Water Board growers are required to prepare and management plans. The 4 R's of nitrogen management serve as guiding nitrogen efficiencies principles that growers are recommended to follow when developing their management plans. The identified measure is addressed through two of the four principles. The "Right time" principle refers to timed application of nitrogen to ensure availability to the plant during periods of greatest demand. The measure is also addressed through the "Right place" principle, which considers targeted application of fertilizer in the crop's effective rootzones to facilitate and enhance the uptake of nitrogen by the crop.

As described by Guthrie et al. (2018), ammonia emissions can be reduced by 50-90 percent through this measure, should the fertilizer be mixed in or injected into the soil within 4-6 hours of their application.[190] Though they do not touch on the speed of the process, Eory et al. (2016) likewise identified fertilizer injection as a candidate ammonia emission mitigation measure.[191] However, the publications referenced in Guthrie et al. (2018) and Eory et al. (2016) focus solely on manure application methods and do not provide estimates for commercial fertilizers. [192,193] We cannot assume the mitigation potential of fertilizers to be consistent with that of manure sources. We therefore proceed with caution with the identified measure and will not be considering it at this moment. In addition to this, research from a California-context is profoundly limited,[194] resulting in uncertainty regarding the ammonia reduction potentials under California-specific conditions. Consistent with the previously mentioned fertilizer measures, Guthrie et al. (2018) and Eory et al. (2016) merely identify the measure, and do not reference any specific regulations.

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[190] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). Impact of ammonia emissions from agriculture on biodiversity: An evidence synthesis. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html

[191] Eory, V., Rees, B., Topp, K., Dewhurst, R., et al. ClimateXChange, "On-farm technologies for the reduction of greenhouse gas emissions in Scotland," March 2016. Retrieved from: https://www.climatexchange.org.uk/media/1927/on-farm_technology_report.pdf

[192] Loyon, L., C.H. Burton, T. Misselbrook, J. Webb, F.X. Philippe, M. Aguilar, M. Doreau, M. Hassouna, T. Veldkamp, J.Y. Dourmad, A. Bonmati, E. Grimm, S.G. Sommer. (2016). Best available technology for European livestock farms: Availability, effectiveness and uptake. Journal of Environmental Management 166, 1-11. https://doi.org/10.1016/j.jenvman.2015.09.046

[193] Webb, J., B. Pain, S. Bittman, J. Morgan. (2010). he impacts of manure application methods on emissions of ammonia, nitrous oxide and on crop response—A review. Agriculture, Ecosystems & Environment 137:1-2, 39-46. https://doi.org/10.1016/j.agee.2010.01.001

[194] Krauter, C., D. Goorahoo, C. Potter, S. Klooster. (2014). *Ammonia Emissions and Fertilizer Applications in California's Central Valley*. Available at: https://www.cdfa.ca.gov/is/ffldrs/frep/pdfs/completedprojects/00-0515Krauter2006.pdf

Application during optimal weather conditions

Weather conditions (i.e., air temperature, precipitation, and wind speed) have a demonstrated effect on ammonia fluxes.[195] The identified measure would involve rapid incorporation of fertilizers into soils after the fertilizers have been applied. The 4 R's "Right time" principle covers the issue that this measure aims to address. The principle is based on timed nitrogen application in order to ensure the availability of nitrogen to the plant during the more nutrient demanding periods. This period is during vegetative growth in annual crops, and during early fruit and nut development in mature trees and vines.[196]

While describing the fertilizer injection measure, Eory et al. (2016) convey that additional work is needed to determine the emission benefits related to fertilizer application with respect to weather.[197] They however do not provide any additional or specific information regarding a measure or identify the reduction potential of its application. Guthrie et al. (2018) identified weather as affecting ammonia emissions by up to 5 percent and provided the recommendation that growers refrain from using urea-based fertilizers during warm, dry, and windy conditions.[198] After reviewing the two publications referenced in Guthrie et al. (2018) for this measure, Zhang et al. (2017)[199] and Newell et al. (2011)[200], no information regarding concerning weather-related conditions was found. Other publications have demonstrated a link between weather conditions and ammonia emissions, though it is unclear which environmental factors are most appropriate for the various fertilizer types.[201,202] It is particularly important for further research to address the impact of weather and fertilizer application timing under conditions specific to the San Joaquin Valley. Lastly, as has been described previously,

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[195] Li, Q., X. Cui, X. Liu, M. Roelcke, G. Pasda, W. Zerulla, A.H. Wissemeier, X. Chen, K. Goulding, F. Zhang. (2017). A new urease-inhibiting formulation decreases ammonia volatilization and improves maize nitrogen utilization in North China Plain. Scientific Reports 7, 43853. https://doi.org/10.1038/srep43853, https://doi.org/10.1038/srep43853

[196] CDFA. *Irrigation and Nitrogen Management Training for Grower Self-Certification*. Available at: https://www.cdfa.ca.gov/is/ffldrs/frep/pdfs/training/inmtp_workbook.pdf

[197] Eory, V., Rees, B., Topp, K., Dewhurst, R., et al. ClimateXChange, "On-farm technologies for the reduction of greenhouse gas emissions in Scotland," March 2016. Retrieved from: https://www.climatexchange.org.uk/media/1927/on-farm_technology_report.pdf

[198] Guthrie, S., Giles, S., Dunkerley, F., Tabaqchali, H., Harshfield, A., Ioppolo, B., Manville, C. (2018). The Impact of Ammonia Emissions from Agriculture on Biodiversity. *Rand Europe, The Royal Society.* Retrieved from: https://www.rand.org/pubs/research_reports/RR2695.html

[199] Zhang, Y., A.L. Collins, J.I. Jones, P.J. Johnes, A. Inman, J.E. Freer. (2017). The potential benefits of on-farm mitigation scenarios for reducing multiple pollutant loadings in prioritised agri-environment areas across England. Environmental Science & Policy 73, 100-114. https://doi.org/10.1016/j.envsci.2017.04.004

[200] Newell Price, J.P., D. Harris, M. Taylor, J.R. Williams, S.G. Anthony, D. Duethmann, R.D. Gooday, E.I. Lord, B.J. Chambers, D.R. Chadwick, T.H. Misselbrook. "An Inventory of Mitigation Methods and Guide to their Effects on Diffuse Water Pollution, Greenhouse Gas Emissions and Ammonia Emissions from Agriculture," December 2011. Retrieved from: https://repository.rothamsted.ac.uk/download/942687eab7ec4b83751c7e241d62f0fa8472d72adcd25a149bb891b7c30d55d0/1595300/MitigationMethods-UserGuideDecember2011FINAL.pdf

[201] V Venterea, R.T., A.D. Halvorson, N. Kitchen, M.A. Liebig, M.A. Cavigelli, S.J. Del Grosso, P.P. Motavalli, K.A. Nelson, K.A. Spokas, B. Pal Singh, C.E. Stewart, A. Ranaivoson, J. Strock, H. Collins. (2012). Challenges and opportunities for mitigating nitrous oxide emissions from fertilized cropping systems. Frontiers in Ecology and the Environment 10:10, 562-570. https://doi.org/10.1890/120062

[202] Grahmann, K., N. Verhulst, A. Buerkert, I. Ortiz-Monasterio, B. Govaerts. (2013). Nitrogen use efficiency and optimization of nitrogen fertilization in conservation agriculture. Cabi Reviews 8:053. https://doi.org/10.1079/PAVSNNR20138053

Guthrie et al. (2018) and Eory et al. (2016) do not refer to any specific regulations when identifying the measure.

CARB has not identified effective mechanisms within its authority to regulate air emissions of ammonia from livestock, which overwhelmingly come from the decomposition of manure, or from fertilizers, the second largest category of emissions in the Valley. CARB's main source of authority is the California Health and Safety Code. CARB's authority is primarily over mobile sources, consumer products, and air toxics, as well as methane from livestock (see Cal. Health & Saf. Code §§ 43013, 39666, 39730.7, 41712).

Estimated feasible reductions in ammonia from this emissions source in the Valley are zero tons.

Composting and Other Sources

The District already regulates ammonia emissions from composting operations through District Rules 4565 and 4566. Based on the mitigation measures in practice at facilities subject to Rule 4565 and 4566, ammonia emissions are already being reduced by 44 percent. With these controls in place, composting accounts for only 3 percent of the District's ammonia emissions; therefore, the District will not be further evaluating this source category at this time.

The other source category consists of ammonia emissions primarily from mobile sources and fuel combustion, which are heavily controlled. Therefore, the District will not be further evaluating this source at this time.
Estimated feasible reductions in ammonia from these emissions sources in the Valley are zero tons.

Research

CARB is working to fill knowledge gaps on feasible and effective ammonia controls. Development of effective air pollution mitigation strategies for ammonia requires additional spatiotemporal understanding of atmospheric ammonia emissions that are currently lacking as a result of limited data. CARB is conducting research, both in-house and with external partners, to characterize gaseous ammonia emissions from agricultural activities in the San Joaquin Valley. The results of these studies will help future development of CARB's ammonia emission inventory, SIP, Short-Lived Climate Pollutant Reduction Strategy, and community air protection program (AB 617). Findings from these research projects will help CARB better characterize ammonia emissions in the Valley, as a necessary prerequisite to identifying potential effective measures to achieve additional emissions reductions.

Ammonia emissions in general are not well quantified Statewide and further focused study is needed to facilitate quantification and potential further control strategies that are effective and cost-effective. As an example of the agency's work in this area, CARB's

Research Division has developed a new mobile measurement platform equipped with a state-of-the-science ammonia analyzer and other advanced analytical instruments to improve the understanding of various ammonia sources in California. In September and October 2018, CARB staff collaborated with researchers from the University of California, Davis, to quantify emissions from several dairies in the Valley as part of the ongoing projects funded by the California Department of Food and Agriculture, CARB, and industry. Methane, oxides of nitrogen, and other air pollutants and meteorological parameters were measured at or near dairies in addition to ammonia. The major objective is to evaluate the effectiveness of various alternative manure management practices (AMMP) with respect to emission reductions as CARB staff will revisit these dairies after they implement the selected AMMP technologies. This effort is a direct response to Senate Bill 1383 requirements and goals. The AMMP is designed to identify air pollution sources and estimate their emission rates. Its mobility makes it ideal for field measurements that require large spatial coverage, such as mapping ammonia mixing ratios with an emphasis on determining the magnitude of emissions, characterizing spatial variability of emissions, and identifying dominant sources of emissions.

In addition, CARB is undertaking a suite of projects that address research needs. Many projects focus on emissions from dairies, while others, including those with a satellite or remote sensing component, can offer insight into ammonia emissions in the Valley from all source categories. CARB staff is also working with academic researchers and industry representatives to explore potential opportunities to reduce the emissions of ammonia and other air pollutants from dairy manure lagoons which are one of the largest contributors to ammonia in California. Preliminary experiments have been conducted, and further investigation is underway at some Valley dairies with the support from farmers. Additionally, CARB staff is planning to analyze existing satellite data to refine the spatial resolution and allocation of ammonia in California. This may also help evaluate the impact of major wildfires on surface ammonia levels in recent years, and can be used to compare with the estimation methodology in the current ammonia emission inventory associated with wildfires.

Due to research which indicates California is underestimating ammonia emissions in the air, CARB is reviewing and will reassess ammonia estimates in recognition of this research. This effort will help us update our understanding about modeled sensitivity of PM2.5 formation to changes in ammonia emissions.

4.3.3 Conclusion

CARB has followed the Guidance to evaluate whether ammonia contributes significantly to PM2.5 levels that exceed the 12 $\mu g/m^3$ annual PM2.5 NAAQS. Considering relevant contextualizing information such as emissions, research, and available controls, along with performing sensitivity-based analysis for the future attainment year, CARB determined that emissions of ammonia do not contribute significantly to PM2.5 levels that exceed the 12 $\mu g/m^3$ annual NAAQS in the area. Therefore, CARB has excluded ammonia from control requirements in the SIP.

While the Guidance recommends modeling emissions reductions of PM2.5 precursors of between 30 and 70 percent to evaluate if precursor emissions reductions have a significant impact on PM2.5 levels, CARB and the District have determined that the 30 percent reduction in ammonia emissions is not achievable. Moreover, CARB and the District have not identified methods within its authority to control air emissions of ammonia that achieve an overall 30 percent reduction in ammonia emissions. In practice, the District has implemented the best available control measures on livestock operations that have already achieved approximately 25 percent reduction from this source. CARB is not aware of controls that would achieve greater reductions on the order needed to achieve an overall 30 percent reduction of ammonia emissions in the Valley; nevertheless, CARB is pursuing further research specific to California and the Valley to improve our understanding of ammonia emissions from various sources as a necessary prerequisite to identifying potential effective measures to achieve additional emissions reductions.

The District and CARB analyzed potential control measures to reduce ammonia emissions from key source categories in order to evaluate whether a 30 percent reduction in emissions is feasible. Specific to the confined animal facility category, the District conducted a new, extensive evaluation of potential measures to control sources of ammonia emissions. EPA provided the list of measures to CARB and the District and requested that the measures and studies referenced be addressed specifically for the Valley. In this evaluation, the District has identified only a few measures that have the theoretical potential to reduce additional ammonia emissions beyond the practices currently enforced through District Rule 4570. These measures are reducing crude protein content in feed for beef finishing cattle, incorporation of solid manure within 24 hours, and acidifying amendments for poultry litter and manure. Despite the technological and economic feasibility issues of these mitigation measures, the District evaluated the potential emission reductions and the impact they might have on the Valley's total ammonia emissions inventory if these measures were to be implemented. Overall, ammonia emissions in the Valley can only be reduced from the confined animal facilities source category by 2 percent by implementing these mitigation measures. For the fertilizer category, CARB has not identified effective mechanisms within its authority to regulate air emissions of ammonia from livestock, which overwhelmingly come from the decomposition of manure, or from fertilizers. Furthermore, CARB and the District are unaware of any other jurisdictions with rules for the source. In addition, CARB and the District did not identify feasible control measures for composting or other emissions sources.

Based on the extensive evaluation which identified feasible reductions of only approximately 2 percent, as summarized below in Table 4-15, CARB and the District conclude that a 30 percent reduction in ammonia emissions is not achievable.

Table 4-15 Estimated Feasible Emission Reductions

Emissions Category	Emissions (tpd, 2030)	Identified Controls	Feasible Ammonia Reductions
Confined Animal Feeding	167.2	• Reducing crude protein content in feed for beef finishing cattle • Incorporation of solid manure within 24 hours • Acidifying amendments for poultry litter and manure	6.5 tpd
Fertilizers	109.9	No authority or feasible controls identified	0
Composting	9.3	No feasible controls identified	0
Other sources	20.2	No feasible controls identified	0
Total Ammonia	306.5		6.5 tpd

Numbers may not add up due to rounding.

A 2 percent reduction is consistent with the national trend identified in U.S. EPA guidance which stated that ammonia changes ranged nationally from an increase of six percent to a decrease of nine percent.[203] Moving forward, updated national guidance on ammonia emission reductions achievable in practice is needed, as well as guidance on available and feasible control measures.

[203] EPA. *PM2.5 Precursor Demonstration Guidance*. May 2019. https://www.epa.gov/sites/production/files/2019-05/documents/transmittal_memo_and_pm25_precursor_demo_guidance_5_30_19.pdf

4.4 SULFUR DIOXIDE ANALYSIS

Ammonium sulfate ([NH4]2SO4) is a constituent of PM2.5, making up about 12 percent of fine particulate matter mass in the Valley in 2017. Sulfur oxides (SOx) emitted from stationary and mobile combustion sources, mostly as sulfur dioxide (SO2), are oxidized in the atmosphere to ultimately form sulfuric acid (H2SO4). Sulfuric acid then combines with ammonia to form ammonium sulfate. Since SOx reacts chemically in this way to form a particle, SOx is a precursor to PM2.5.

Following the analytical process outlined in the Guidance and summarized above, CARB has evaluated SOx in the Valley. The results of the sensitivity-based analysis and consideration of additional information are presented below.

4.4.1 Sensitivity-Based Analysis

CARB staff used an air quality model to estimate the PM2.5 design value for the annual standard in the base year of 2017 at each Valley monitor. Then, CARB staff applied the recommended lower bound of a 30 percent reduction to SOx emissions and used the air quality model to estimate the PM2.5 design values, as shown in Table 4-16. The difference between the two design values represents the modeled impact on PM2.5 levels of a 30 percent reduction in SOx emissions in 2017. This is the value that is compared to U.S. EPA's recommended contribution threshold of 0.2 μg/m^3 for the 12 μg/m^3 annual standard to establish if PM2.5 levels are sensitive to this level of SOx reduction.

Table 4-16 Base Year 2017 PM2.5 – 30 Percent SOx Reduction

Site	2017 Baseline DV	2017 DV with 30% SOx Reduction	Difference
Bakersfield-Planz	16.97	16.94	0.03
Hanford	15.73	15.91	-0.18
Bakersfield-Golden	15.52	15.51	0.01
Visalia	15.43	15.39	0.04
Bakersfield-California	15.12	15.11	0.01
Corcoran	14.95	15.10	-0.15
Fresno-Hamilton	13.99	13.99	0
Fresno-Garland	13.69	13.72	-0.03
Turlock	12.7	12.88	-0.18
Clovis	12.69	12.88	-0.19
Merced-SCoffee	12.28	12.50	-0.22
Stockton	12.21	12.48	-0.27
Madera	12.11	12.30	-0.19
Merced-MStreet	11.73	11.75	-0.02
Modesto	11.16	11.39	-0.23
Manteca	10.37	10.60	-0.23
Tranquility	8.19	8.33	-0.14

For completeness, CARB staff repeated this analysis, applying instead the recommended upper bound of a 70 percent reduction to the SOx emissions in the base year, as shown in Table 4-17.

Table 4-17 Base Year 2017 PM2.5 – 70 Percent SOx Reduction

Site	2017 Baseline DV	2017 DV with 70% SOx Reduction	Difference
Bakersfield-Planz	16.97	16.92	0.05
Hanford	15.73	15.90	-0.17
Bakersfield-Golden	15.52	15.49	0.03
Visalia	15.43	15.32	0.11
Bakersfield-California	15.12	15.10	0.02
Corcoran	14.95	15.12	-0.17
Fresno-Hamilton	13.99	13.93	0.06
Fresno-Garland	13.69	13.66	0.03
Turlock	12.7	12.87	-0.17
Clovis	12.69	12.97	-0.28
Merced-SCoffee	12.28	12.49	-0.21
Stockton	12.21	12.46	-0.25
Madera	12.11	12.31	-0.20
Merced-MStreet	11.73	11.72	0.01
Modesto	11.16	11.37	-0.21
Manteca	10.37	10.58	-0.21
Tranquility	8.19	8.35	-0.16

From this analysis, the estimated air quality impact of reducing SOx emissions in the base year by the lower bound of 30 percent is well under U.S. EPA's recommended threshold at all Valley monitors. In fact, in some cases, the estimated air quality impact is negative, implying that a reduction in SOx emissions would in fact increase PM2.5 levels at certain sites. Reducing emissions by the upper bound of 70 percent also shows impacts below the recommended threshold at all Valley sites.

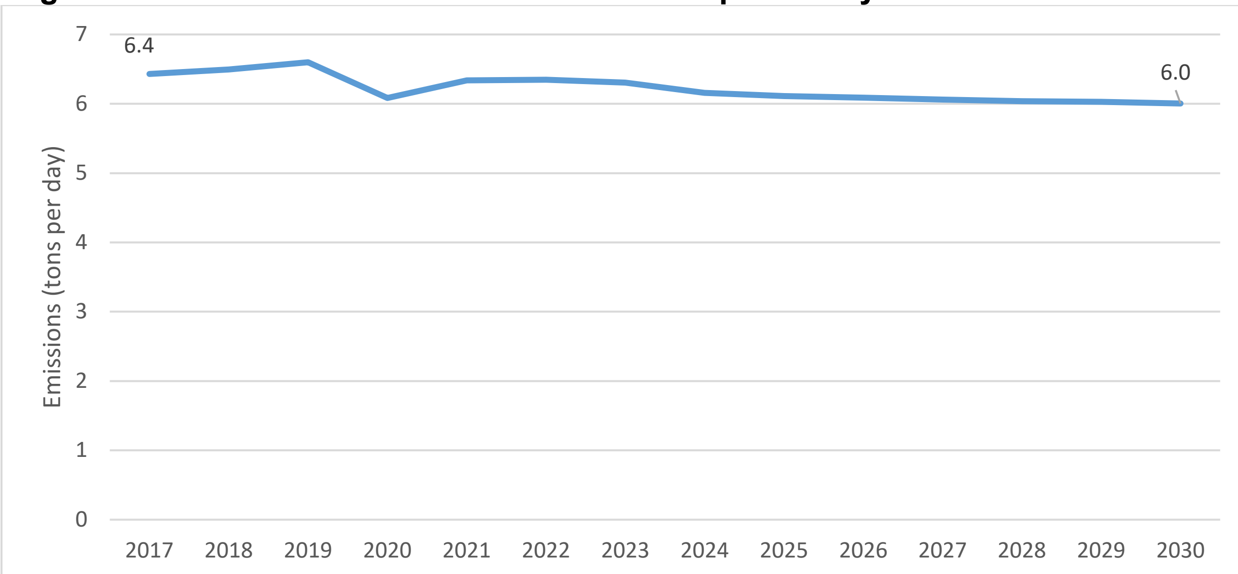
4.4.2 Consideration of Additional Information

To supplement modeling analysis, the Guidance also allows an air agency to consider additional information. Accordingly, CARB evaluated the trend of SOx emissions in the Valley to support the sensitivity-based analysis.

4.4.2.1 Emissions Trend

CARB's SOx inventory indicates that emissions remain roughly constant between 2017 and 2030, dropping 0.4 tpd or 6.7 percent, as shown in Figure 4-8. Ammonia emissions also remain flat over the same time frame, as shown above in Figure 4-1. Thus, conditions for ammonium sulfate formation are similar in the base and future years, with relative levels of ammonia and SOx remaining the same.

Figure 4-8 SOx emission trend in the San Joaquin Valley between 2017 and 2030



Source: CEPAM 2022 v 1.00

4.4.2.2 Future Year Modeling

Analysis of SOx and ammonia emissions trends, discussed above, indicates that the sensitivity-based analysis performed for 2017 in Table 4-16 and Table 4-17 above is representative into the future with the Valley's emissions conditions remaining similar to the base year.

For completeness, however, CARB staff repeated the sensitivity-based analysis of SOx for the future attainment year of 2030 in accordance with the Guidance. Staff used an air quality model to estimate the PM2.5 design value for the annual standard in 2030 at each Valley monitor. Then, CARB staff applied a 30 percent reduction to SOx emissions and used the air quality model to estimate the PM2.5 design values in 2030, shown in Table 4-18. The difference between the two design values represents the modeled impact on PM2.5 levels of a 30 percent reduction in ammonia emissions in the attainment year. The future-year modeling includes emission reductions from measures in the CARB-adopted 2022 State SIP Strategy.

Table 4-18 Future Year 2030 PM2.5 – 30 Percent SOx Reduction

Site	2030 Baseline DV	2030 DV with 30% SOx Reduction	Difference
Bakersfield-Planz	14.05	13.99	0.06
Hanford	11.17	11.11	0.06
Bakersfield-Golden	12.48	12.42	0.06
Visalia	12.41	12.32	0.09
Bakersfield-California	12.39	12.33	0.06
Corcoran	10.71	10.68	0.03
Fresno-Hamilton	11.77	11.7	0.07
Fresno-Garland	11.55	11.49	0.06
Turlock	10.33	10.3	0.03
Clovis	9.91	9.88	0.03
Merced-SCoffee	9.61	9.59	0.02
Stockton	10.7	10.68	0.02
Madera	9.17	9.14	0.03
Merced-MStreet	9.96	9.92	0.04
Modesto	9.3	9.27	0.03
Manteca	8.85	8.82	0.03
Tranquility	6.37	6.37	0

For completeness, CARB staff repeated this analysis, applying instead the recommended upper bound of a 70 percent reduction to the SOx emissions in 2030, as shown in Table 4-19.

Table 4-19 Future Year 2030 PM2.5 – 70 Percent SOx Reduction

Site	2030 Baseline DV	2030 DV with 70% SOx Reduction	Difference
Bakersfield-Planz	14.05	13.94	0.11
Hanford	11.17	11.05	0.12
Bakersfield-Golden	12.48	12.38	0.10
Visalia	12.41	12.23	0.18
Bakersfield-California	12.39	12.28	0.11
Corcoran	10.71	10.66	0.05
Fresno-Hamilton	11.77	11.62	0.15
Fresno-Garland	11.55	11.42	0.13
Turlock	10.33	10.27	0.06
Clovis	9.91	9.88	0.03
Merced-SCoffee	9.61	9.56	0.05
Stockton	10.7	10.66	0.04
Madera	9.17	9.11	0.06
Merced-MStreet	9.96	9.88	0.08
Modesto	9.3	9.24	0.06
Manteca	8.85	8.79	0.06
Tranquility	6.37	6.38	-0.01

From this analysis, the estimated air quality impact of reducing SOx emissions by 30 percent and by 70 percent in 2030 continues to fall under U.S. EPA's recommended threshold of 0.2 $\mu g/m^3$ for the 12 $\mu g/m^3$ annual PM2.5 standard at all sites.

4.4.3 Conclusion

CARB has followed the Guidance to evaluate whether SOx contributes significantly to PM2.5 levels that exceed the NAAQS. Using sensitivity-based analysis in the base year and future year, CARB determined that emissions of SOx do not contribute significantly to PM2.5 levels that exceed the 2012 NAAQS in the area. Therefore, CARB has excluded SOx from control requirements in the SIP.

4.5 REACTIVE ORGANIC GAS ANALYSIS

Following the analytical process outlined in the Guidance and summarized above, CARB has evaluated Reactive Organic Gas (ROG) in the San Joaquin Valley. The results of the sensitivity-based analysis and consideration of additional information are presented below.

4.5.1 Sensitivity-Based Analysis

CARB staff used an air quality model to estimate the PM2.5 design value for the annual standard in the base year of 2017 at each Valley monitor. Then, CARB staff applied the recommended lower bound of a 30 percent reduction to ROG emissions and used the air quality model to estimate the PM2.5 design values, as shown in Table 4-20. The difference between the two design values represents the modeled impact on PM2.5 levels of a 30 percent reduction in ROG emissions in 2017. This is the value that is compared to U.S. EPA's recommended contribution threshold of 0.2 $\mu g/m^3$ for the 12 $\mu g/m^3$ annual standard to establish if PM2.5 levels are sensitive to this level of ROG reduction.

Table 4-20 Base Year 2017 PM2.5 – 30 Percent ROG Reduction

Site	2017 Baseline DV	2017 DV with 30% ROG Reduction	Difference
Bakersfield-Planz	16.97	16.89	0.08
Hanford	15.73	15.89	-0.16
Bakersfield-Golden	15.52	15.49	0.03
Visalia	15.43	15.35	0.08
Bakersfield-California	15.12	15.08	0.04
Corcoran	14.95	15.09	-0.14
Fresno-Hamilton	13.99	13.94	0.05
Fresno-Garland	13.69	13.68	0.01
Turlock	12.7	12.82	-0.12
Clovis	12.69	12.8	-0.11
Merced-SCoffee	12.28	12.46	-0.18
Stockton	12.21	12.44	-0.23
Madera	12.11	12.24	-0.13
Merced-MStreet	11.73	11.72	0.01
Modesto	11.16	11.35	-0.19
Manteca	10.37	10.56	-0.19
Tranquility	8.19	8.3	-0.11

For completeness, CARB staff repeated this analysis, applying instead the U.S. EPA-recommended upper bound of a 70 percent reduction to ROG emissions in the base year, as shown in Table 4-21.

Table 4-21 Base Year 2017 PM2.5 – 70 Percent ROG Reduction

Site	2017 Baseline DV	2017 DV with 70% ROG Reduction	Difference
Bakersfield-Planz	16.97	16.74	0.23
Hanford	15.73	15.82	-0.09
Bakersfield-Golden	15.52	15.38	0.14
Visalia	15.43	15.19	0.24
Bakersfield-California	15.12	14.97	0.15
Corcoran	14.95	15.04	-0.09
Fresno-Hamilton	13.99	13.8	0.19
Fresno-Garland	13.69	13.55	0.14
Turlock	12.7	12.71	-0.01
Clovis	12.69	12.7	-0.01
Merced-SCoffee	12.28	12.39	-0.11
Stockton	12.21	12.34	-0.13
Madera	12.11	12.14	-0.03
Merced-MStreet	11.73	11.64	0.09
Modesto	11.16	11.25	-0.09
Manteca	10.37	10.47	-0.10
Tranquility	8.19	8.29	-0.10

From this analysis, the estimated air quality impact of reducing ROG emissions in the base year by the lower bound of 30 percent is below U.S. EPA's recommended annual threshold of 0.2 μg/m^3 at all sites. Reducing emissions by the upper bound of 70 percent shows impacts above the threshold at two of the sites.

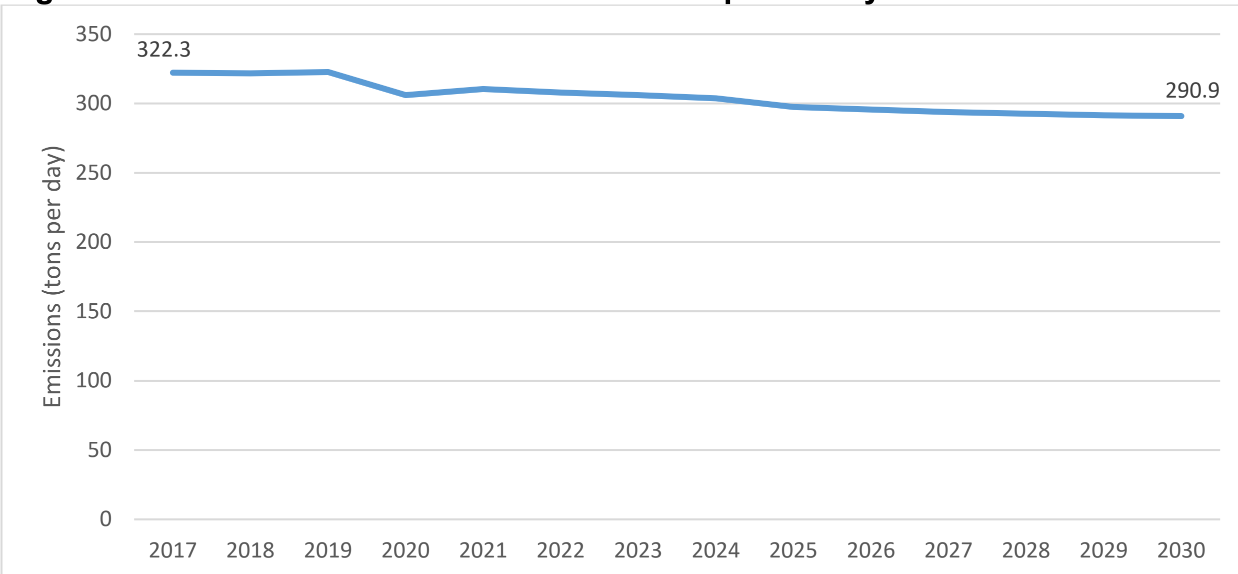
4.5.2 Consideration of Additional Information

To supplement modeling analysis, the Guidance also allows an air agency to consider additional information. Accordingly, CARB evaluated the trend of ROG emissions in the Valley to support the sensitivity-based analysis and conducted future year sensitivity modeling.

4.5.2.1 Emissions Trend

CARB has an extensive suite of measures in place to reduce ROG emissions, particularly in the area of regulating consumer products. In addition, the District has numerous rules that provide ROG emissions reductions in the Valley. CARB's ROG inventory indicates that these existing controls reduce emissions by 18.4 tpd, or 5.7 percent, between 2017 and 2030, as shown in Figure 4-9. Considering the change and that CARB's 2022 State SIP Strategy provides additional ROG reductions beyond the base year, it is important to evaluate the role ROG plays in PM2.5 formation and whether it may differ in the base and future years, as the sensitivity-based analysis performed for 2017 may not be representative into the future.

Figure 4-9 ROG emission trend in the San Joaquin Valley between 2017 and 2030



Source: CEPAM 2022 v.1.00

4.5.2.2 Future Year Modeling

Analysis of ROG emission trends, discussed above, indicates that the sensitivity-based analysis performed for 2017 in Table 20 and Table 21 above is representative into the future with the Valley's emissions conditions remaining similar to the base year.
For completeness, however, CARB staff repeated the sensitivity-based analysis of ROG for the future attainment year of 2030 in accordance with the Guidance. Staff used an air quality model to estimate the PM2.5 design value for the annual standard in 2030 at each Valley monitor. Then, CARB staff applied a 30 percent reduction to ROG emissions and used the air quality model to estimate the PM2.5 design values in 2030, shown in Table 4-22. The difference between the two design values represents the modeled impact on PM2.5 levels of a 30 percent reduction in ROG emissions in the attainment year. The future-year modeling includes NOx and PM2.5 emission reductions from measures in the CARB-adopted 2022 State SIP Strategy.

Table 4-22 Future Year 2030 PM2.5 – 30 Percent ROG Reduction

Site	2030 Baseline DV	2030 DV with 30% ROG Reduction	Difference
Bakersfield-Planz	14.05	14.01	0.04
Hanford	11.17	11.19	-0.02
Bakersfield-Golden	12.48	12.45	0.03
Visalia	12.41	12.38	0.03
Bakersfield-California	12.39	12.36	0.03
Corcoran	10.71	10.73	-0.02
Fresno-Hamilton	11.77	11.71	0.06
Fresno-Garland	11.55	11.50	0.05
Turlock	10.33	10.32	0.01

Site	2030 Baseline DV	2030 DV with 30% ROG Reduction	Difference
Clovis	9.91	9.89	0.02
Merced-SCoffee	9.61	9.61	0
Stockton	10.7	10.69	0.01
Madera	9.17	9.16	0.01
Merced-MStreet	9.96	9.94	0.02
Modesto	9.3	9.28	0.02
Manteca	8.85	8.83	0.02
Tranquility	6.37	6.38	-0.01

For completeness, CARB staff repeated this analysis, applying instead the recommended upper bound of a 70 percent reduction to ROG emissions in 2030, as shown in Table 4-23.

Table 4-23 Future Year 2030 PM2.5 – 70 Percent ROG Reduction

Site	2030 Baseline DV	2030 DV with 70% ROG Reduction	Difference
Bakersfield-Planz	14.05	13.96	0.09
Hanford	11.17	11.23	-0.06
Bakersfield-Golden	12.48	12.42	0.06
Visalia	12.41	12.34	0.07
Bakersfield-California	12.39	12.32	0.07
Corcoran	10.71	10.77	-0.06
Fresno-Hamilton	11.77	11.63	0.14
Fresno-Garland	11.55	11.44	0.11
Turlock	10.33	10.3	0.03
Clovis	9.91	9.88	0.03
Merced-SCoffee	9.61	9.62	-0.01
Stockton	10.7	10.67	0.03
Madera	9.17	9.15	0.02
Merced-MStreet	9.96	9.9	0.06
Modesto	9.3	9.26	0.04
Manteca	8.85	8.81	0.04
Tranquility	6.37	6.38	-0.01

From this analysis, in 2030, the modeled air quality impact of reducing ROG emissions by 30 percent and 70 percent falls under U.S. EPA's recommended threshold at all sites.

4.5.3 Conclusion

CARB has followed the Guidance to evaluate whether ROG contributes significantly to PM2.5 levels that exceed the 12 µg/m^3 annual NAAQS. Using sensitivity-based analysis in the base and future years, CARB determined that emissions of ROG do not contribute significantly to PM2.5 levels that exceed the 2012 NAAQS in the area. Therefore, CARB has excluded ROG from control requirements in the SIP.

Chapter 5
EMISSIONS INVENTORY

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TABLE OF CONTENTS

TABLE OF TABLES

Chapter 5: Emissions Inventory

Emissions inventories are one of the fundamental building blocks in the development of an attainment plan. Emissions inventories serve as 1) a primary input to air quality modeling used in attainment demonstrations; 2) the emissions data used for developing control strategies; and 3) a means to track progress in meeting the emission reduction commitments. The inventories in this chapter are used to study and propose control measures, to track emissions for Reasonable Further Progress (RFP), to establish motor vehicle conformity budgets for transportation planning, and to assist in demonstrating attainment.

Emissions inventories are an estimate of the air pollution emissions that are actually released into the environment. They are not measurements of ambient concentrations. The following are examples of pollution sources by key sectors:

- Industrial or stationary point sources (e.g., power plants and oil refineries);
- Area-wide sources (e.g., consumer products and residential fuel combustion);
- On-road sources (e.g., passenger vehicles and heavy-duty trucks);
- Off-road mobile sources (e.g., aircraft, trains, ships, recreational boats, construction equipment and farm equipment); and
- Non-anthropogenic (natural) sources (e.g., biogenic or vegetation, geogenic (petroleum seeps), and wildfires).

Emissions inventories are usually developed at various geographical resolutions encompassing district, air basin, and county levels. The inventories presented in this chapter are the emissions for the San Joaquin Valley Air Basin.

This section includes emissions for the San Joaquin Valley Air Basin for the years 2017 through 2031.[1] The tables in this section include:

- Table 5-1 Directly Emitted PM2.5
- Table 5-2 NOx
- Table 5-3 SOx
- Table 5-4 VOC
- Table 5-5 Ammonia

Tables 5-1 through 5-5 are followed by an overview of emissions inventory calculations and revisions.

[1] Emission Inventory data source is CEPAM v.1.00.

5.1 EMISSIONS INVENTORY TABLES

Table 5-1 Directly Emitted PM2.5

PM2.5														
SUMMARY CATEGORY NAME	Annual Average (tons/day)							Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
STATIONARY SOURCES														
FUEL COMBUSTION														
ELECTRIC UTILITIES	1.1	1.0	1.0	0.9	0.8	0.7	0.7	1.1	1.0	1.0	0.9	0.8	0.7	0.7
COGENERATION	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
OIL AND GAS PRODUCTION (COMBUSTION)	1.9	1.8	1.6	1.5	1.4	1.3	1.3	1.9	1.8	1.6	1.5	1.4	1.3	1.3
PETROLEUM REFINING (COMBUSTION)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MANUFACTURING AND INDUSTRIAL	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
FOOD AND AGRICULTURAL PROCESSING	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4
SERVICE AND COMMERCIAL	0.4	0.5	0.5	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0.5	0.5	0.5	0.5
OTHER (FUEL COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL FUEL COMBUSTION**	**4.7**	**4.5**	**4.2**	**4.0**	**3.8**	**3.6**	**3.6**	**4.6**	**4.4**	**4.1**	**3.9**	**3.7**	**3.5**	**3.5**
WASTE DISPOSAL														
SEWAGE TREATMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LANDFILLS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
INCINERATORS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOIL REMEDIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (WASTE DISPOSAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL WASTE DISPOSAL**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
CLEANING AND SURFACE COATINGS														
LAUNDERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEGREASING	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1

SUMMARY CATEGORY NAME	PM2.5 Annual Average (tons/day)							PM2.5 Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
COATINGS AND RELATED PROCESS SOLVENTS	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
PRINTING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ADHESIVES AND SEALANTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (CLEANING AND SURFACE COATINGS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL CLEANING AND SURFACE COATINGS**	**0.3**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.3**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**	**0.4**
PETROLEUM PRODUCTION AND MARKETING														
OIL AND GAS PRODUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM REFINING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM MARKETING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
INDUSTRIAL PROCESSES														
CHEMICAL	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
FOOD AND AGRICULTURE	0.7	0.7	0.7	0.7	0.7	0.8	0.8	0.4	0.4	0.4	0.5	0.5	0.5	0.5
MINERAL PROCESSES	1.2	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.1
METAL PROCESSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOD AND PAPER	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
GLASS AND RELATED PRODUCTS	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
*** TOTAL INDUSTRIAL PROCESSES**	**2.6**	**2.6**	**2.5**	**2.5**	**2.5**	**2.5**	**2.6**	**2.3**	**2.3**	**2.3**	**2.2**	**2.2**	**2.3**	**2.3**
***** TOTAL STATIONARY***	***7.9***	***7.6***	***7.4***	***7.1***	***6.9***	***6.8***	***6.8***	***7.5***	***7.3***	***7.1***	***6.7***	***6.5***	***6.4***	***6.4***

SUMMARY CATEGORY NAME	PM2.5 Annual Average (tons/day)							Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
AREAWIDE SOURCES														
SOLVENT EVAPORATION														
CONSUMER PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PESTICIDES/FERTILIZERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ASPHALT PAVING / ROOFING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL SOLVENT EVAPORATION**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
MISCELLANEOUS PROCESSES														
RESIDENTIAL FUEL COMBUSTION	3.3	3.1	3.0	3.0	3.0	3.0	3.0	6.1	5.6	5.5	5.5	5.5	5.5	5.5
FARMING OPERATIONS	13.2	13.1	13.0	12.9	12.8	12.7	12.7	9.4	9.3	9.2	9.1	9.0	9.0	9.0
CONSTRUCTION AND DEMOLITION	1.3	1.4	1.5	1.7	1.7	2.8	1.8	1.2	1.3	1.4	1.6	1.5	2.6	1.7
PAVED ROAD DUST	4.7	4.9	5.0	5.2	5.4	5.5	5.6	4.5	4.6	4.8	5.0	5.2	5.3	5.3
UNPAVED ROAD DUST	3.7	3.7	3.7	3.7	3.7	3.7	3.7	2.6	2.6	2.6	2.6	2.6	2.6	2.6
FUGITIVE WINDBLOWN DUST	7.4	7.3	7.3	7.2	7.1	7.1	7.1	4.7	4.6	4.6	4.5	4.4	4.4	4.4
FIRES	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
MANAGED BURNING AND DISPOSAL	13.2	16.1	13.2	6.0	6.0	5.9	5.9	15.8	21.1	14.9	5.1	5.1	5.0	5.0
COOKING	3.8	3.9	3.9	4.1	4.2	4.3	4.3	3.8	3.9	3.9	4.1	4.2	4.3	4.3
OTHER (MISCELLANEOUS PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL MISCELLANEOUS PROCESSES**	**50.9**	**53.7**	**50.9**	**44.0**	**44.0**	**45.3**	**44.3**	**48.3**	**53.3**	**47.1**	**37.7**	**37.7**	**38.9**	**38.0**
***** TOTAL AREAWIDE***	***50.9***	***53.7***	***50.9***	***44.0***	***44.0***	***45.3***	***44.3***	***48.3***	***53.3***	***47.1***	***37.7***	***37.7***	***38.9***	***38.0***

SUMMARY CATEGORY NAME	PM2.5 Annual Average (tons/day)							PM2.5 Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
MOBILE SOURCES														
ON-ROAD MOTOR VEHICLES														
LIGHT DUTY PASSENGER (LDA)	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
LIGHT DUTY TRUCKS - 1 (LDT1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT DUTY TRUCKS - 2 (LDT2)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MEDIUM DUTY TRUCKS (MDV)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LIGHT HEAVY DUTY TRUCKS - 1 (LHDT1)	0.3	0.2	0.2	0.2	0.2	0.2	0.1	0.3	0.2	0.2	0.2	0.2	0.2	0.1
LIGHT HEAVY DUTY TRUCKS - 2 (LHDT2)	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.0	0.0
MEDIUM HEAVY DUTY TRUCKS (MHDT)	0.3	0.2	0.1	0.0	0.0	0.0	0.0	0.3	0.2	0.1	0.0	0.0	0.0	0.0
HEAVY HEAVY DUTY TRUCKS (HHDT)	1.5	1.1	0.6	0.5	0.5	0.5	0.6	1.5	1.1	0.6	0.5	0.5	0.5	0.6
MOTORCYCLES (MCY)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOTOR HOMES (MH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL ON-ROAD MOTOR VEHICLES**	**2.7**	**2.2**	**1.6**	**1.4**	**1.3**	**1.3**	**1.3**	**2.7**	**2.3**	**1.6**	**1.4**	**1.3**	**1.3**	**1.3**
OTHER MOBILE SOURCES														
AIRCRAFT	1.2	1.7	1.7	1.7	1.7	1.7	1.7	1.2	1.7	1.7	1.7	1.7	1.7	1.7
TRAINS	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
OCEAN GOING VESSELS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMMERCIAL HARBOR CRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RECREATIONAL BOATS	0.6	0.6	0.5	0.4	0.4	0.4	0.4	0.3	0.3	0.3	0.2	0.2	0.2	0.2
OFF-ROAD RECREATIONAL VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD EQUIPMENT	0.9	0.8	0.8	0.6	0.5	0.5	0.4	0.8	0.7	0.7	0.6	0.5	0.4	0.4
OFF-ROAD EQUIPMENT (PERP)	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1
FARM EQUIPMENT	2.4	1.9	1.6	1.3	1.1	0.9	0.9	1.5	1.2	1.0	0.8	0.7	0.6	0.6

SUMMARY CATEGORY NAME	PM2.5 Annual Average (tons/day)							PM2.5 Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
FUEL STORAGE AND HANDLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL OTHER MOBILE SOURCES**	**5.7**	**5.5**	**5.0**	**4.5**	**4.1**	**3.9**	**3.8**	**4.4**	**4.4**	**4.1**	**3.7**	**3.4**	**3.3**	**3.2**
***** TOTAL MOBILE***	***8.4***	***7.7***	***6.6***	***5.9***	***5.4***	***5.2***	***5.1***	***7.1***	***6.6***	***5.6***	***5.1***	***4.8***	***4.6***	***4.5***

GRAND TOTAL FOR SAN JOAQUIN VALLEY	**2017**	**2019**	**2022**	**2025**	**2028**	**2030**	**2031**	**2017**	**2019**	**2022**	**2025**	**2028**	**2030**	**2031**
	67.1	69.1	64.9	56.9	56.3	57.2	56.1	62.9	67.3	59.8	49.5	49.1	49.9	48.9

Table 5-2 NOx

NOx														
SUMMARY CATEGORY NAME	Annual Average (tons/day)							Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
STATIONARY SOURCES														
FUEL COMBUSTION														
ELECTRIC UTILITIES	2.8	2.6	2.5	2.5	2.3	2.2	2.2	2.8	2.6	2.5	2.4	2.3	2.2	2.2
COGENERATION	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7	0.7
OIL AND GAS PRODUCTION (COMBUSTION)	2.8	2.5	2.2	1.8	1.6	1.4	1.4	2.7	2.5	2.2	1.8	1.6	1.4	1.4
PETROLEUM REFINING (COMBUSTION)	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
MANUFACTURING AND INDUSTRIAL	1.4	1.4	1.4	1.3	1.3	1.3	1.3	1.3	1.3	1.3	1.2	1.2	1.2	1.2
FOOD AND AGRICULTURAL PROCESSING	5.5	5.0	4.4	3.8	3.3	3.0	2.9	3.9	3.6	3.1	2.7	2.4	2.2	2.1
SERVICE AND COMMERCIAL	4.7	4.9	4.8	4.3	4.2	4.1	4.1	5.1	5.3	5.2	4.7	4.6	4.5	4.5
OTHER (FUEL COMBUSTION)	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.4	0.4	0.4	0.4	0.4
*** TOTAL FUEL COMBUSTION**	**18.7**	**18.0**	**16.8**	**15.1**	**14.1**	**13.5**	**13.3**	**17.3**	**16.7**	**15.7**	**14.2**	**13.3**	**12.8**	**12.6**
WASTE DISPOSAL														
SEWAGE TREATMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LANDFILLS	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
INCINERATORS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOIL REMEDIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (WASTE DISPOSAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL WASTE DISPOSAL**	**0.3**	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.2**	**0.3**	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.2**
CLEANING AND SURFACE COATINGS														
LAUNDERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEGREASING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRINTING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SUMMARY CATEGORY NAME	NOx Annual Average (tons/day)							NOx Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
ADHESIVES AND SEALANTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (CLEANING AND SURFACE COATINGS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL CLEANING AND SURFACE COATINGS**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
PETROLEUM PRODUCTION AND MARKETING														
OIL AND GAS PRODUCTION	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1
PETROLEUM REFINING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM MARKETING	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**0.3**	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.1**	**0.3**	**0.3**	**0.3**	**0.2**	**0.2**	**0.2**	**0.1**
INDUSTRIAL PROCESSES														
CHEMICAL	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
FOOD AND AGRICULTURE	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MINERAL PROCESSES	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
METAL PROCESSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOD AND PAPER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GLASS AND RELATED PRODUCTS	3.1	3.1	3.4	2.8	2.8	1.7	1.7	3.1	3.1	3.4	2.8	2.8	1.7	1.7
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL INDUSTRIAL PROCESSES**	**3.6**	**3.7**	**3.9**	**3.3**	**3.3**	**2.3**	**2.3**	**3.6**	**3.7**	**3.9**	**3.3**	**3.3**	**2.3**	**2.3**
***** TOTAL STATIONARY***	***23.0***	***22.3***	***21.3***	***18.8***	***17.8***	***16.2***	***16.0***	***21.5***	***21.0***	***20.2***	***17.9***	***17.0***	***15.5***	***15.3***

NOx														
SUMMARY CATEGORY NAME	Annual Average (tons/day)							Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
AREAWIDE SOURCES														
SOLVENT EVAPORATION														
CONSUMER PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PESTICIDES/FERTILIZERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ASPHALT PAVING / ROOFING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL SOLVENT EVAPORATION**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
MISCELLANEOUS PROCESSES														
RESIDENTIAL FUEL COMBUSTION	5.3	5.2	4.9	4.7	4.6	4.5	4.4	7.5	7.4	6.9	6.6	6.4	6.3	6.3
FARMING OPERATIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION AND DEMOLITION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UNPAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUGITIVE WINDBLOWN DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIRES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANAGED BURNING AND DISPOSAL	6.9	7.2	6.8	1.8	1.8	1.8	1.8	9.1	9.6	8.9	2.3	2.2	2.2	2.2
COOKING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (MISCELLANEOUS PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL MISCELLANEOUS PROCESSES**	**12.3**	**12.4**	**11.7**	**6.5**	**6.4**	**6.3**	**6.2**	**16.7**	**17.0**	**15.9**	**8.9**	**8.7**	**8.6**	**8.5**
***** TOTAL AREAWIDE***	***12.3***	***12.4***	***11.7***	***6.5***	***6.4***	***6.3***	***6.2***	***16.7***	***17.0***	***15.9***	***8.9***	***8.7***	***8.6***	***8.5***

SUMMARY CATEGORY NAME	NOx													
	Annual Average (tons/day)							Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
MOBILE SOURCES														
ON-ROAD MOTOR VEHICLES														
LIGHT DUTY PASSENGER (LDA)	7.3	5.8	4.2	3.2	2.6	2.2	2.1	8.1	6.4	4.7	3.6	2.9	2.5	2.3
LIGHT DUTY TRUCKS - 1 (LDT1)	2.0	1.8	1.2	0.8	0.6	0.4	0.4	2.2	2.0	1.4	0.9	0.6	0.5	0.4
LIGHT DUTY TRUCKS - 2 (LDT2)	5.9	4.3	3.2	2.4	2.0	1.7	1.6	6.5	4.8	3.6	2.7	2.2	1.9	1.8
MEDIUM DUTY TRUCKS (MDV)	7.7	6.4	4.6	3.1	2.2	1.8	1.6	8.6	7.2	5.1	3.5	2.4	2.0	1.8
LIGHT HEAVY DUTY TRUCKS - 1 (LHDT1)	8.4	7.4	6.0	4.5	3.3	2.7	2.4	8.6	7.6	6.2	4.6	3.4	2.8	2.5
LIGHT HEAVY DUTY TRUCKS - 2 (LHDT2)	2.1	1.9	1.6	1.2	1.0	0.8	0.8	2.2	2.0	1.6	1.3	1.0	0.8	0.8
MEDIUM HEAVY DUTY TRUCKS (MHDT)	9.6	7.7	3.6	2.3	1.7	1.5	1.3	9.8	7.8	3.7	2.3	1.8	1.5	1.4
HEAVY HEAVY DUTY TRUCKS (HHDT)	59.2	45.4	28.7	13.8	11.0	10.2	9.9	60.3	46.3	29.3	14.1	11.3	10.4	10.2
MOTORCYCLES (MCY)	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.4	0.3	0.3	0.3	0.2	0.2	0.2
BUSES	1.6	1.2	0.8	0.6	0.5	0.4	0.4	1.6	1.2	0.8	0.6	0.5	0.4	0.4
MOTOR HOMES (MH)	0.3	0.2	0.2	0.2	0.1	0.1	0.1	0.3	0.3	0.2	0.2	0.2	0.1	0.1
*** TOTAL ON-ROAD MOTOR VEHICLES**	**104.3**	**82.4**	**54.4**	**32.4**	**25.1**	**22.0**	**20.8**	**108.5**	**85.8**	**56.9**	**34.1**	**26.4**	**23.2**	**21.8**
OTHER MOBILE SOURCES														
AIRCRAFT	2.5	4.6	4.5	4.5	4.5	4.5	4.5	2.4	4.5	4.5	4.5	4.5	4.5	4.5
TRAINS	13.1	14.3	15.0	15.5	16.1	16.5	16.6	13.1	14.3	15.0	15.5	16.1	16.5	16.6
OCEAN GOING VESSELS	0.1	0.1	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.1	0.1	0.1	0.1
COMMERCIAL HARBOR CRAFT	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0
RECREATIONAL BOATS	2.7	2.6	2.5	2.4	2.4	2.4	2.3	1.3	1.3	1.2	1.2	1.2	1.2	1.2
OFF-ROAD RECREATIONAL VEHICLES	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.2
OFF-ROAD EQUIPMENT	21.2	19.4	16.6	13.8	11.7	10.6	10.2	18.5	17.0	14.6	12.2	10.5	9.6	9.2
OFF-ROAD EQUIPMENT (PERP)	5.9	5.1	3.3	2.6	2.2	2.2	2.2	5.9	5.1	3.3	2.6	2.2	2.2	2.2
FARM EQUIPMENT	41.5	36.1	29.6	24.2	19.7	17.3	16.2	25.8	22.6	18.5	15.1	12.3	10.8	10.1

NOx														
SUMMARY CATEGORY NAME	**Annual Average (tons/day)**							**Winter Average (tons/day)**						
	2017	**2019**	**2022**	**2025**	**2028**	**2030**	**2031**	**2017**	**2019**	**2022**	**2025**	**2028**	**2030**	**2031**
FUEL STORAGE AND HANDLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL OTHER MOBILE SOURCES**	**87.1**	**82.3**	**71.7**	**63.3**	**56.8**	**53.7**	**52.2**	**67.2**	**64.9**	**57.3**	**51.4**	**47.0**	**45.0**	**44.0**
***** TOTAL MOBILE***	***191.4***	***164.7***	***126.1***	***95.7***	***82.0***	***75.7***	***73.0***	***175.7***	***150.7***	***114.1***	***85.5***	***73.4***	***68.1***	***65.8***

GRAND TOTAL FOR SAN JOAQUIN VALLEY	**2017**	**2019**	**2022**	**2025**	**2028**	**2030**	**2031**	**2017**	**2019**	**2022**	**2025**	**2028**	**2030**	**2031**
	226.7	**199.5**	**159.1**	**121.1**	**106.2**	**98.2**	**95.2**	**213.9**	**188.8**	**150.2**	**112.3**	**99.2**	**92.2**	**89.6**

Table 5-3 SOx

SUMMARY CATEGORY NAME	SOx Annual Average (tons/day)							SOx Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
STATIONARY SOURCES														
FUEL COMBUSTION														
ELECTRIC UTILITIES	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
COGENERATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OIL AND GAS PRODUCTION (COMBUSTION)	0.7	0.6	0.6	0.5	0.5	0.5	0.4	0.7	0.6	0.6	0.5	0.5	0.5	0.4
PETROLEUM REFINING (COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANUFACTURING AND INDUSTRIAL	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
FOOD AND AGRICULTURAL PROCESSING	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.2	0.2	0.2
SERVICE AND COMMERCIAL	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3
OTHER (FUEL COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL FUEL COMBUSTION**	**1.6**	**1.6**	**1.5**	**1.4**	**1.4**	**1.3**	**1.3**	**1.6**	**1.6**	**1.5**	**1.4**	**1.4**	**1.3**	**1.3**
WASTE DISPOSAL														
SEWAGE TREATMENT	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LANDFILLS	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
INCINERATORS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOIL REMEDIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (WASTE DISPOSAL)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL WASTE DISPOSAL**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**	**0.2**
CLEANING AND SURFACE COATINGS														
LAUNDERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEGREASING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRINTING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SOx														
SUMMARY CATEGORY NAME	Annual Average (tons/day)							Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
ADHESIVES AND SEALANTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (CLEANING AND SURFACE COATINGS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL CLEANING AND SURFACE COATINGS**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
PETROLEUM PRODUCTION AND MARKETING														
OIL AND GAS PRODUCTION	0.5	0.4	0.4	0.4	0.3	0.3	0.3	0.5	0.4	0.4	0.4	0.3	0.3	0.3
PETROLEUM REFINING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM MARKETING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**0.5**	**0.5**	**0.4**	**0.4**	**0.3**	**0.3**	**0.3**	**0.5**	**0.5**	**0.4**	**0.4**	**0.3**	**0.3**	**0.3**
INDUSTRIAL PROCESSES														
CHEMICAL	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
FOOD AND AGRICULTURE	0.5	0.4	0.4	0.5	0.5	0.5	0.5	0.2	0.2	0.2	0.2	0.2	0.2	0.2
MINERAL PROCESSES	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
METAL PROCESSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOD AND PAPER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GLASS AND RELATED PRODUCTS	1.5	1.5	1.6	1.5	1.5	1.5	1.5	1.5	1.5	1.6	1.5	1.5	1.5	1.5
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.1	0.1
*** TOTAL INDUSTRIAL PROCESSES**	**2.8**	**2.8**	**2.8**	**2.8**	**2.8**	**2.9**	**2.9**	**2.5**	**2.5**	**2.6**	**2.5**	**2.6**	**2.6**	**2.6**
***** TOTAL STATIONARY***	***5.1***	***5.0***	***5.0***	***4.8***	***4.8***	***4.8***	***4.8***	***4.8***	***4.8***	***4.7***	***4.6***	***4.5***	***4.5***	***4.5***

SOx														
SUMMARY CATEGORY NAME	Annual Average (tons/day)							Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
AREAWIDE SOURCES														
SOLVENT EVAPORATION														
CONSUMER PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PESTICIDES/FERTILIZERS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ASPHALT PAVING / ROOFING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL SOLVENT EVAPORATION**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
MISCELLANEOUS PROCESSES														
RESIDENTIAL FUEL COMBUSTION	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.4	0.4	0.4	0.4	0.4	0.4	0.4
FARMING OPERATIONS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CONSTRUCTION AND DEMOLITION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UNPAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUGITIVE WINDBLOWN DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIRES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANAGED BURNING AND DISPOSAL	0.3	0.5	0.3	0.3	0.3	0.3	0.3	0.3	0.6	0.3	0.2	0.2	0.2	0.2
COOKING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (MISCELLANEOUS PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL MISCELLANEOUS PROCESSES**	**0.6**	**0.7**	**0.6**	**0.5**	**0.5**	**0.5**	**0.5**	**0.7**	**1.0**	**0.6**	**0.5**	**0.5**	**0.5**	**0.5**
***** TOTAL AREAWIDE***	***0.6***	***0.7***	***0.6***	***0.5***	***0.5***	***0.5***	***0.5***	***0.7***	***1.0***	***0.6***	***0.5***	***0.5***	***0.5***	***0.5***

SUMMARY CATEGORY NAME	SOx Annual Average (tons/day)							SOx Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
MOBILE SOURCES														
ON-ROAD MOTOR VEHICLES														
LIGHT DUTY PASSENGER (LDA)	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LIGHT DUTY TRUCKS - 1 (LDT1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT DUTY TRUCKS - 2 (LDT2)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MEDIUM DUTY TRUCKS (MDV)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LIGHT HEAVY DUTY TRUCKS - 1 (LHDT1)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LIGHT HEAVY DUTY TRUCKS - 2 (LHDT2)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MEDIUM HEAVY DUTY TRUCKS (MHDT)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
HEAVY HEAVY DUTY TRUCKS (HHDT)	0.2	0.2	0.2	0.2	0.1	0.1	0.1	0.2	0.2	0.2	0.2	0.1	0.1	0.1
MOTORCYCLES (MCY)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MOTOR HOMES (MH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL ON-ROAD MOTOR VEHICLES**	**0.6**	**0.6**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**	**0.5**
OTHER MOBILE SOURCES														
AIRCRAFT	0.1	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2	0.2	0.2	0.2	0.2	0.2
TRAINS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OCEAN GOING VESSELS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMMERCIAL HARBOR CRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RECREATIONAL BOATS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD RECREATIONAL VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD EQUIPMENT (PERP)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FARM EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SOx														
SUMMARY CATEGORY NAME	Annual Average (tons/day)							Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
FUEL STORAGE AND HANDLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL OTHER MOBILE SOURCES**	**0.2**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.2**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**	**0.3**
***** TOTAL MOBILE***	***0.8***	***0.9***	***0.8***	***0.8***	***0.8***	***0.8***	***0.8***	***0.7***	***0.8***	***0.8***	***0.8***	***0.8***	***0.7***	***0.7***

GRAND TOTAL FOR SAN JOAQUIN VALLEY	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
	6.43	6.64	6.39	6.15	6.08	6.04	6.04	6.24	6.58	6.15	5.87	5.79	5.75	5.74

Table 5-4 VOC

SUMMARY CATEGORY NAME	VOC Annual Average (tons/day) 2017	2019	2022	2025	2028	2030	2031	Winter Average (tons/day) 2017	2019	2022	2025	2028	2030	2031
STATIONARY SOURCES														
FUEL COMBUSTION														
ELECTRIC UTILITIES	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1
COGENERATION	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
OIL AND GAS PRODUCTION (COMBUSTION)	1.1	1.1	1.0	0.9	0.8	0.8	0.8	1.1	1.1	1.0	0.9	0.8	0.8	0.8
PETROLEUM REFINING (COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANUFACTURING AND INDUSTRIAL	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.2
FOOD AND AGRICULTURAL PROCESSING	0.7	0.6	0.6	0.6	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
SERVICE AND COMMERCIAL	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.7	0.7
OTHER (FUEL COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL FUEL COMBUSTION**	**3.3**	**3.2**	**3.1**	**2.9**	**2.8**	**2.7**	**2.7**	**3.2**	**3.1**	**3.0**	**2.8**	**2.7**	**2.6**	**2.6**
WASTE DISPOSAL														
SEWAGE TREATMENT	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LANDFILLS	1.5	1.5	1.6	1.6	1.6	1.7	1.7	1.5	1.5	1.6	1.6	1.6	1.7	1.7
INCINERATORS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOIL REMEDIATION	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
OTHER (WASTE DISPOSAL)	21.6	21.9	21.7	22.7	23.5	24.2	24.6	21.5	21.9	21.7	22.7	23.5	24.2	24.6
*** TOTAL WASTE DISPOSAL**	**23.2**	**23.6**	**23.4**	**24.5**	**25.3**	**26.0**	**26.4**	**23.2**	**23.6**	**23.4**	**24.5**	**25.3**	**26.0**	**26.4**
CLEANING AND SURFACE COATINGS														
LAUNDERING	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
DEGREASING	1.8	1.8	1.8	1.9	2.0	2.0	2.1	1.8	1.8	1.8	1.9	2.0	2.0	2.1
COATINGS AND RELATED PROCESS SOLVENTS	8.8	8.9	9.5	10.1	10.3	10.5	10.6	8.8	8.9	9.5	10.1	10.3	10.5	10.6
PRINTING	5.6	5.5	5.3	5.3	5.3	5.4	5.4	5.6	5.5	5.3	5.3	5.3	5.4	5.4

VOC														
SUMMARY CATEGORY NAME	Annual Average (tons/day)							Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
ADHESIVES AND SEALANTS	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
OTHER (CLEANING AND SURFACE COATINGS)	7.0	7.0	7.5	8.0	8.0	8.1	8.1	7.0	7.0	7.5	8.0	8.0	8.1	8.1
*** TOTAL CLEANING AND SURFACE COATINGS**	**24.0**	**24.0**	**24.9**	**26.1**	**26.4**	**26.7**	**27.0**	**24.0**	**24.0**	**24.9**	**26.1**	**26.3**	**26.7**	**27.0**
PETROLEUM PRODUCTION AND MARKETING														
OIL AND GAS PRODUCTION	11.5	10.8	9.9	9.0	8.2	7.8	7.6	11.5	10.8	9.9	9.0	8.2	7.8	7.5
PETROLEUM REFINING	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
PETROLEUM MARKETING	5.1	4.8	4.4	4.1	3.9	3.8	3.8	5.1	4.8	4.4	4.1	3.9	3.8	3.8
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**17.0**	**16.0**	**14.8**	**13.6**	**12.6**	**12.1**	**11.8**	**17.0**	**16.0**	**14.7**	**13.6**	**12.6**	**12.1**	**11.8**
INDUSTRIAL PROCESSES														
CHEMICAL	2.6	2.6	2.5	2.6	2.6	2.7	2.8	2.6	2.6	2.4	2.6	2.6	2.7	2.7
FOOD AND AGRICULTURE	12.4	12.4	12.6	13.3	13.9	14.4	14.7	11.9	12.0	12.2	12.8	13.4	13.9	14.2
MINERAL PROCESSES	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.1	0.1	0.1
METAL PROCESSES	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
WOOD AND PAPER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GLASS AND RELATED PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.6	0.6	0.6	0.7	0.7	0.7	0.7	0.8	0.8	0.8	0.8	0.9	0.9	0.9
*** TOTAL INDUSTRIAL PROCESSES**	**16.0**	**16.0**	**16.1**	**16.9**	**17.6**	**18.2**	**18.6**	**15.7**	**15.7**	**15.8**	**16.6**	**17.3**	**17.9**	**18.2**
***** TOTAL STATIONARY***	***83.5***	***82.9***	***82.2***	***84.0***	***84.7***	***85.7***	***86.5***	***83.0***	***82.5***	***81.8***	***83.6***	***84.2***	***85.3***	***86.0***

SUMMARY CATEGORY NAME	VOC Annual Average (tons/day)							VOC Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
AREAWIDE SOURCES														
SOLVENT EVAPORATION														
CONSUMER PRODUCTS	25.8	26.7	27.2	28.4	29.5	30.4	30.9	25.8	26.7	27.2	28.4	29.5	30.4	30.9
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	6.0	6.1	6.3	6.5	6.7	6.8	6.9	5.3	5.4	5.6	5.7	5.9	6.0	6.1
PESTICIDES/FERTILIZERS	18.1	17.4	17.7	17.6	17.4	17.3	17.3	15.4	14.3	16.5	16.4	16.2	16.2	16.1
ASPHALT PAVING / ROOFING	1.0	1.1	1.2	1.2	1.3	1.3	1.3	1.0	1.1	1.2	1.2	1.3	1.3	1.3
*** TOTAL SOLVENT EVAPORATION**	**51.0**	**51.4**	**52.4**	**53.7**	**54.9**	**55.9**	**56.4**	**47.5**	**47.6**	**50.5**	**51.7**	**52.9**	**53.9**	**54.5**
MISCELLANEOUS PROCESSES														
RESIDENTIAL FUEL COMBUSTION	3.7	3.4	3.3	3.3	3.3	3.3	3.3	6.9	6.4	6.2	6.2	6.3	6.3	6.3
FARMING OPERATIONS	93.8	93.7	93.6	93.5	93.5	93.4	93.4	93.8	93.7	93.6	93.5	93.4	93.4	93.4
CONSTRUCTION AND DEMOLITION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UNPAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUGITIVE WINDBLOWN DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIRES	0.1	0.1	0.1	0.1	0.1	0.2	0.2	0.1	0.1	0.1	0.1	0.1	0.2	0.2
MANAGED BURNING AND DISPOSAL	17.3	24.4	17.6	11.2	11.2	11.2	11.2	18.3	31.3	16.2	7.7	7.7	7.7	7.7
COOKING	0.6	0.6	0.6	0.6	0.7	0.7	0.7	0.6	0.6	0.6	0.6	0.7	0.7	0.7
OTHER (MISCELLANEOUS PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL MISCELLANEOUS PROCESSES**	**115.5**	**122.2**	**115.3**	**108.9**	**108.8**	**108.8**	**108.8**	**119.7**	**132.0**	**116.8**	**108.2**	**108.1**	**108.1**	**108.1**
***** TOTAL AREAWIDE***	***166.5***	***173.7***	***167.7***	***162.5***	***163.7***	***164.7***	***165.2***	***167.2***	***179.6***	***167.2***	***159.9***	***161.1***	***162.0***	***162.6***

SUMMARY CATEGORY NAME	VOC Annual Average (tons/day)							VOC Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
MOBILE SOURCES														
ON-ROAD MOTOR VEHICLES														
LIGHT DUTY PASSENGER (LDA)	9.6	8.3	7.0	5.9	5.2	4.7	4.4	9.5	8.2	6.9	5.8	5.1	4.7	4.4
LIGHT DUTY TRUCKS - 1 (LDT1)	2.5	2.4	1.9	1.3	1.0	0.8	0.8	2.5	2.4	1.8	1.3	1.0	0.8	0.7
LIGHT DUTY TRUCKS - 2 (LDT2)	4.8	3.9	3.5	3.1	2.8	2.6	2.5	4.8	3.9	3.5	3.1	2.9	2.6	2.5
MEDIUM DUTY TRUCKS (MDV)	6.0	5.5	4.7	3.9	3.3	2.9	2.7	6.2	5.7	4.8	4.0	3.3	2.9	2.8
LIGHT HEAVY DUTY TRUCKS - 1 (LHDT1)	1.6	1.5	1.3	1.0	0.9	0.7	0.7	1.6	1.5	1.3	1.0	0.8	0.7	0.6
LIGHT HEAVY DUTY TRUCKS - 2 (LHDT2)	0.3	0.3	0.3	0.2	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.2	0.2
MEDIUM HEAVY DUTY TRUCKS (MHDT)	0.7	0.6	0.2	0.1	0.1	0.1	0.1	0.7	0.6	0.2	0.1	0.1	0.1	0.1
HEAVY HEAVY DUTY TRUCKS (HHDT)	2.2	1.6	0.7	0.6	0.6	0.6	0.6	2.2	1.6	0.7	0.6	0.6	0.6	0.6
MOTORCYCLES (MCY)	2.2	2.1	2.0	1.9	1.8	1.7	1.7	2.2	2.1	2.0	1.8	1.7	1.7	1.6
BUSES	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.0	0.0	0.0
MOTOR HOMES (MH)	0.1	0.1	0.1	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.0	0.0	0.0	0.0
*** TOTAL ON-ROAD MOTOR VEHICLES**	**30.2**	**26.5**	**21.6**	**18.2**	**15.9**	**14.4**	**13.7**	**30.2**	**26.4**	**21.5**	**18.1**	**15.8**	**14.3**	**13.6**
OTHER MOBILE SOURCES														
AIRCRAFT	3.0	3.9	3.9	3.9	3.9	3.9	3.9	3.0	3.9	3.9	3.9	3.9	3.9	3.9
TRAINS	0.6	0.6	0.7	0.6	0.7	0.7	0.7	0.6	0.6	0.7	0.6	0.7	0.7	0.7
OCEAN GOING VESSELS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMMERCIAL HARBOR CRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RECREATIONAL BOATS	14.1	12.9	11.3	10.0	8.9	8.2	7.9	6.8	6.2	5.4	4.8	4.3	4.0	3.8
OFF-ROAD RECREATIONAL VEHICLES	2.4	2.3	2.2	2.0	1.7	1.5	1.5	2.8	2.7	2.5	2.2	1.9	1.7	1.7
OFF-ROAD EQUIPMENT	12.4	12.0	11.8	10.6	8.3	7.1	6.6	11.8	11.4	11.2	10.0	7.9	6.8	6.3
OFF-ROAD EQUIPMENT (PERP)	0.5	0.4	0.3	0.3	0.3	0.3	0.3	0.5	0.4	0.3	0.3	0.3	0.3	0.3
FARM EQUIPMENT	7.4	6.8	5.7	4.9	4.1	3.7	3.5	5.0	4.5	3.8	3.2	2.7	2.4	2.3

VOC														
SUMMARY CATEGORY NAME	**Annual Average (tons/day)**							**Winter Average (tons/day)**						
	2017	**2019**	**2022**	**2025**	**2028**	**2030**	**2031**	**2017**	**2019**	**2022**	**2025**	**2028**	**2030**	**2031**
FUEL STORAGE AND HANDLING	1.5	1.4	1.3	1.2	1.2	1.2	1.2	1.3	1.3	1.2	1.1	1.1	1.1	1.1
*** TOTAL OTHER MOBILE SOURCES**	**41.9**	**40.3**	**37.2**	**33.5**	**29.0**	**26.6**	**25.6**	**31.9**	**31.0**	**29.0**	**26.2**	**22.7**	**20.8**	**20.0**
***** TOTAL MOBILE***	***72.2***	***66.8***	***58.8***	***51.7***	***44.9***	***41.0***	***39.3***	***62.0***	***57.4***	***50.4***	***44.3***	***38.5***	***35.1***	***33.7***

GRAND TOTAL FOR SAN JOAQUIN VALLEY	**2017**	**2019**	**2022**	**2025**	**2028**	**2030**	**2031**	**2017**	**2019**	**2022**	**2025**	**2028**	**2030**	**2031**
	322.1	**323.4**	**308.7**	**298.3**	**293.3**	**291.4**	**291.0**	**312.2**	**319.5**	**299.5**	**287.8**	**283.8**	**282.4**	**282.2**

Table 5-5 Ammonia

SUMMARY CATEGORY NAME	Ammonia Annual Average (tons/day)							Ammonia Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
STATIONARY SOURCES														
FUEL COMBUSTION														
ELECTRIC UTILITIES	0.8	0.7	0.7	0.6	0.6	0.5	0.5	0.7	0.7	0.7	0.6	0.6	0.5	0.5
COGENERATION	0.4	0.3	0.3	0.3	0.3	0.3	0.3	0.4	0.3	0.3	0.3	0.3	0.3	0.3
OIL AND GAS PRODUCTION (COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM REFINING (COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANUFACTURING AND INDUSTRIAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FOOD AND AGRICULTURAL PROCESSING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SERVICE AND COMMERCIAL	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (FUEL COMBUSTION)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL FUEL COMBUSTION**	**1.2**	**1.1**	**1.1**	**1.1**	**1.0**	**1.0**	**1.0**	**1.2**	**1.1**	**1.1**	**1.0**	**1.0**	**0.9**	**0.9**
WASTE DISPOSAL														
SEWAGE TREATMENT	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
LANDFILLS	0.7	0.7	0.8	0.8	0.8	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.8	0.8
INCINERATORS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
SOIL REMEDIATION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (WASTE DISPOSAL)	10.9	11.1	11.1	11.5	11.9	12.2	12.4	10.9	11.1	11.1	11.5	11.9	12.2	12.4
*** TOTAL WASTE DISPOSAL**	**11.7**	**11.9**	**11.9**	**12.4**	**12.8**	**13.1**	**13.3**	**11.7**	**11.9**	**11.9**	**12.4**	**12.8**	**13.1**	**13.3**
CLEANING AND SURFACE COATINGS														
LAUNDERING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DEGREASING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PRINTING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

SUMMARY CATEGORY NAME	Ammonia Annual Average (tons/day)							Ammonia Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
ADHESIVES AND SEALANTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (CLEANING AND SURFACE COATINGS)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL CLEANING AND SURFACE COATINGS**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
PETROLEUM PRODUCTION AND MARKETING														
OIL AND GAS PRODUCTION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM REFINING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PETROLEUM MARKETING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (PETROLEUM PRODUCTION AND MARKETING)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL PETROLEUM PRODUCTION AND MARKETING**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**	**0.0**
INDUSTRIAL PROCESSES														
CHEMICAL	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
FOOD AND AGRICULTURE	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MINERAL PROCESSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
METAL PROCESSES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
WOOD AND PAPER	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
GLASS AND RELATED PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ELECTRONICS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (INDUSTRIAL PROCESSES)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL INDUSTRIAL PROCESSES**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
***** TOTAL STATIONARY***	***13.0***	***13.1***	***13.1***	***13.6***	***13.9***	***14.2***	***14.4***	***13.0***	***13.1***	***13.0***	***13.5***	***13.9***	***14.2***	***14.3***

SUMMARY CATEGORY NAME	Ammonia Annual Average (tons/day)							Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
AREAWIDE SOURCES														
SOLVENT EVAPORATION														
CONSUMER PRODUCTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
ARCHITECTURAL COATINGS AND RELATED PROCESS SOLVENTS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PESTICIDES/FERTILIZERS	115.2	114.3	113.0	111.7	110.6	109.9	109.5	95.8	95.0	93.9	92.8	91.8	91.2	90.9
ASPHALT PAVING / ROOFING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL SOLVENT EVAPORATION**	**115.2**	**114.3**	**113.0**	**111.7**	**110.6**	**109.9**	**109.5**	**95.8**	**95.0**	**93.9**	**92.8**	**91.8**	**91.2**	**90.9**
MISCELLANEOUS PROCESSES														
RESIDENTIAL FUEL COMBUSTION	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.7	0.7	0.7	0.7	0.7	0.7	0.7
FARMING OPERATIONS	169.9	169.3	168.6	168.0	167.4	167.2	167.0	169.8	169.2	168.5	167.9	167.4	167.1	166.9
CONSTRUCTION AND DEMOLITION	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
PAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
UNPAVED ROAD DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FUGITIVE WINDBLOWN DUST	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FIRES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
MANAGED BURNING AND DISPOSAL	0.6	1.0	0.6	0.6	0.6	0.6	0.6	0.5	1.2	0.4	0.4	0.4	0.4	0.4
COOKING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OTHER (MISCELLANEOUS PROCESSES)	6.5	6.6	6.7	6.9	7.1	7.3	7.3	6.5	6.6	6.7	6.9	7.1	7.3	7.3
*** TOTAL MISCELLANEOUS PROCESSES**	**177.3**	**177.2**	**176.3**	**175.9**	**175.6**	**175.4**	**175.3**	**177.6**	**177.8**	**176.4**	**176.0**	**175.7**	**175.5**	**175.5**
***** TOTAL AREAWIDE***	**292.6**	**291.5**	**289.3**	**287.6**	**286.2**	**285.3**	**284.9**	**273.4**	**272.8**	**270.3**	**268.8**	**267.5**	**266.7**	**266.4**

Ammonia														
SUMMARY CATEGORY NAME	Annual Average (tons/day)							Winter Average (tons/day)						
	2017	2019	2022	2025	2028	2030	2031	2017	2019	2022	2025	2028	2030	2031
MOBILE SOURCES														
ON-ROAD MOTOR VEHICLES														
LIGHT DUTY PASSENGER (LDA)	1.3	1.5	1.6	1.7	1.9	2.0	2.0	1.3	1.5	1.6	1.7	1.9	2.0	2.0
LIGHT DUTY TRUCKS - 1 (LDT1)	0.2	0.2	0.2	0.1	0.1	0.1	0.1	0.2	0.2	0.2	0.1	0.1	0.1	0.1
LIGHT DUTY TRUCKS - 2 (LDT2)	0.5	0.6	0.7	0.8	0.9	1.0	1.0	0.5	0.6	0.7	0.8	0.9	1.0	1.0
MEDIUM DUTY TRUCKS (MDV)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
LIGHT HEAVY DUTY TRUCKS - 1 (LHDT1)	0.3	0.4	0.4	0.4	0.3	0.3	0.3	0.3	0.4	0.4	0.4	0.3	0.3	0.3
LIGHT HEAVY DUTY TRUCKS - 2 (LHDT2)	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MEDIUM HEAVY DUTY TRUCKS (MHDT)	0.2	0.2	0.3	0.3	0.4	0.4	0.4	0.2	0.2	0.3	0.3	0.4	0.4	0.4
HEAVY HEAVY DUTY TRUCKS (HHDT)	1.5	1.7	2.0	2.2	2.3	2.3	2.4	1.5	1.7	2.0	2.2	2.3	2.3	2.4
MOTORCYCLES (MCY)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BUSES	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
MOTOR HOMES (MH)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL ON-ROAD MOTOR VEHICLES**	**4.8**	**5.3**	**6.0**	**6.5**	**6.8**	**6.9**	**7.0**	**4.8**	**5.3**	**6.0**	**6.5**	**6.8**	**6.9**	**7.0**
OTHER MOBILE SOURCES														
AIRCRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
TRAINS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OCEAN GOING VESSELS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
COMMERCIAL HARBOR CRAFT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
RECREATIONAL BOATS	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD RECREATIONAL VEHICLES	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
OFF-ROAD EQUIPMENT (PERP)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
FARM EQUIPMENT	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Ammonia														
SUMMARY CATEGORY NAME	**Annual Average (tons/day)**							**Winter Average (tons/day)**						
	2017	**2019**	**2022**	**2025**	**2028**	**2030**	**2031**	**2017**	**2019**	**2022**	**2025**	**2028**	**2030**	**2031**
FUEL STORAGE AND HANDLING	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
*** TOTAL OTHER MOBILE SOURCES**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**	**0.1**
***** TOTAL MOBILE***	***4.8***	***5.4***	***6.1***	***6.5***	***6.9***	***7.0***	***7.1***	***4.8***	***5.4***	***6.1***	***6.5***	***6.8***	***7.0***	***7.1***

GRAND TOTAL FOR SAN JOAQUIN VALLEY	**2017**	**2019**	**2022**	**2025**	**2028**	**2030**	**2031**	**2017**	**2019**	**2022**	**2025**	**2028**	**2030**	**2031**
	310.4	**310.1**	**308.5**	**307.7**	**306.9**	**306.5**	**306.3**	**291.2**	**291.3**	**289.4**	**288.9**	**288.2**	**287.9**	**287.8**

[The following sections provided by the California Air Resources Board]

5.2 EMISSIONS INVENTORY BACKGROUND

Emissions inventories are required by the Clean Air Act (Act) and the PM2.5 SIP Requirements Rule for the 2012 12 μg/m^3 annual PM2.5 National Ambient Air Quality Standards (NAAQS) (PM2.5 Implementation Rule). Specifically, they are required for those areas that exceed the health-based NAAQS. These areas are designated as nonattainment based on monitored exceedances of these standards. These nonattainment areas must develop an emissions inventory as the basis of a State Implementation Plan (SIP) that demonstrates how they will attain the standards by specified dates. This document describes the emissions inventory included in the San Joaquin Valley (SJV or Valley) 12 μg/m^3 annual PM2.5 SIP (2023 PM2.5 SIP).

5.3 EMISSIONS INVENTORY OVERVIEW

Emissions inventories are estimates of the amount and type of pollutants emitted into the atmosphere by facilities, mobile sources, and areawide sources. They are fundamental components of an air quality plan and serve critical functions such as:

1. the primary input to air quality modeling used in attainment demonstrations;
2. the emissions data used for developing control strategies; and
3. a means to track progress in meeting the emission reduction commitments.

The California Air Resources Board (CARB) and the San Joaquin Valley Air Pollution Control District (District) have developed a comprehensive current emissions inventory consistent with the requirements set forth in Section 182(a)-(f) of the Act[2]. CARB and District staff conducted a thorough review of the inventory to ensure that the emission estimates reflect accurate emissions reports for point sources and that estimates for mobile and areawide sources are based on the most recent approved models and methodologies.

CARB also reviewed the growth profiles for point and areawide source categories and updated them as necessary to ensure that the emission projections are based on data that reflect historical trends, current conditions, and recent economic and demographic forecasts.

The United States Environmental Protection Agency (U.S. EPA) regulations require that the emissions inventory for a PM2.5 SIP contains emissions data for directly emitted PM2.5 and its precursors; oxides of nitrogen (NOx), oxides of sulfur (SOx), volatile organic compounds (VOC)[3] and ammonia (NH3). The inventory included in this plan

[2] Section 182(a)-(f) of the Act. https://www.govinfo.gov/content/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partD-subpart2-sec7511a.htm
[3] Section 182(a)(1) of the Act. https://www.govinfo.gov/content/pkg/USCODE-2013-title42/html/USCODE-2013-title42-chap85-subchapI-partD-subpart2-sec7511a.htm

substitutes VOC with reactive organic gases (ROG), which, in general, represent a slightly broader group of compounds than those in U.S. EPA's list of VOCs.

5.3.1 Inventory Base Year

40 CFR 51.1315(a) requires that the inventory year be selected consistent with the baseline year for the reasonable further progress (RFP) plan as required by 40 CFR 51.1310(b)[4], which states that the base year emissions inventory shall be the emissions inventory for the most recent calendar year of which a complete triennial inventory is required to be submitted to U.S. EPA under the provisions of subpart A of 40 CFR part 51, Air Emissions Reporting Requirements, 40 CFR 51.1– 50. States may also use an alternative baseline emissions inventory provided that the year selected corresponds with the year of the effective date of designation as nonattainment for that NAAQS[5].

2017 Base Year Inventory Justification for 2023 PM2.5 SIP

CARB and the District are selecting 2017 as the planning inventory base year for the 2023 PM2.5 Plan for the 12 μg/m^3 PM2.5 standard. The PM2.5 Implementation Rule specifies that the inventory base year can be one of the years for the PM2.5 design values used to reclassify the area to Serious or the State can justify the use of a different technically appropriate inventory base year if those years are not appropriate[6].
U.S. EPA's final action to reclassify the San Joaquin Valley PM2.5 nonattainment area from Moderate to Serious nonattainment for the 2012 annual PM2.5 standard was based on the agency's determination that the Valley could not practicably attain the standard by the Moderate area attainment date of December 31, 2021. The base year of the Serious area SIP could therefore be any of the three years used to make the determination of impracticability—in this case, 2019, 2020, and 2021; however, CARB and the District believe that 2019, 2020, and 2021 are not technically appropriate base years for the emission inventory and instead determined that 2017 is technically appropriate to use as the base year inventory. In selecting 2017 as the base year, CARB and the District relied on the Emission Inventory Guidance[7], which allows agencies to consider the availability of data, the implementation of rule requirements, and consistency in the base year across planning and modeling inventories in choosing an appropriate baseline inventory year.

<u>Availability of Data</u>
The PM2.5 Implementation Rule specifies that the base year inventory must be actual emissions; follow the Air Emissions Reporting Requirements (AERR), 40 CFR part 51, subpart A for the emissions thresholds for point sources; and use the level of detail as prescribed by the AERR. The National Emissions Inventory (NEI) years follow the AERR

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[4] 40 CFR 51.1315(a). https://www.govinfo.gov/content/pkg/CFR-2021-title40-vol2/pdf/CFR-2021-title40-vol2-sec51-1315.pdf.
[5] 40 CFR 51.1310(b). https://www.govinfo.gov/content/pkg/CFR-2020-title40-vol2/pdf/CFR-2020-title40-vol2-sec51-1310.pdf.
[6] 2016 PM2.5 SIP Requirements Rule, 40 CFR 51.
https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-51/subpart-Z
51.1008(a)(1)(i) and in (b)(2) for Serious areas Emissions inventory requirements. 51.1011 (a)(3) and (b)(3).
[7] Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations (epa.gov)

reporting requirements for point sources and are the most robust inventories of actual emissions available from stationary point sources and area sources. NEI years also undergo a thorough quality assurance/quality control (QA/QC) review performed by U.S. EPA. For these reasons, CARB and the District would prefer to use an NEI year as the base year for the inventory. The two most recent NEI years are 2020 and 2017. In 2020, the COVID-19 pandemic affected a range of industries economy-wide, making 2020 emissions atypical; therefore, 2020 is unsuitable for use as a base year for the inventory. 2017 did not experience any similar disruption and reflects typical emissions, while retaining the benefits of being an NEI year with actual data thoroughly QA/QC'd by U.S. EPA. The rigor associated with an NEI year does not apply to 2019 or 2021, the other two years eligible for consideration as a base year for the 2023 PM2.5 Plan.

Implementation of Rule Requirements

On June 20, 2019, the District adopted amendments to Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters) which addresses emissions from residential wood combustion. Residential wood burning is a significant source of emissions in the San Joaquin Valley, and Rule 4901 provides critical controls for this key emission source. The June 2019 amendments strengthened the rule by:

- Enhancing requirements for significant remodels of a fireplace and chimney that require the removal of open-hearth fireplaces or replacement to cleaner devices;
- Requiring only seasoned wood to be burned;
- Enhancing compliance during transfers of residential real property;
- Restricting installations of new wood burning devices;
- Enhancing visible emission limitations; and
- Establishing lower curtailment thresholds for hot spot counties (Madera, Fresno, and Kern.

Amendments to Rule 4901 went into effect in the fall of 2019. Because of the importance of the emissions source and the control measure, the full year's worth of emission reduction benefits from Rule 4901 are critical to predicting future PM2.5 concentrations. Selecting a base year prior to implementation of these important rule amendments ensures that this rule is accurately reflected in the inventory and credited appropriately for Reasonable Further Progress (RFP). Use of the 2017 NEI year as the inventory base year would meet this criterion.

Consistency in Planning and Modeling Inventories

The Emission Inventory Guidance indicates that a common reason for choosing an alternate base year is the desire to have the base year for planning inventories be consistent with the base year for modeling inventories. The modeling base year is determined in part by meteorology that is conducive to formation of ambient levels of PM2.5 that are above the 12 $\mu g/m^3$ PM2.5 standard. For modeling purposes, 2019, 2020, and 2021 are not years with representative air quality suitable for modeling future air quality. Modeled attainment demonstrations are based on a five-year weighted design value centered around the base year inventory, giving the base year the most weight. To ensure the model is accurately predicting air quality, it is best to have the base year not be a year of extensive wildfires. Wildfires have become more intense in California. The two largest wildfire years on record occurred in 2020 and 2021. In the San Joaquin Valley, these extensive wildfires impacted air quality throughout the Valley for months. 2020 and 2021 are also unusual, non-representative years due to COVID-19 impacts. Furthermore, in 2020, Valley sites collected incomplete speciation data—which are critical for PM2.5 modeling—due to laboratory and monitoring site shutdowns because of the pandemic.

While 2019 is not impacted by wildfires or COVID-19, the five-year weighted PM2.5 design value with a 2019 base year would include 2020 and 2021, capturing those years' significant wildfire and COVID-19 impacts. With a 2017 base modeling year, the five-year weighted PM2.5 design value would include 2017, 2018, and 2019. 2018 did have some wildfire days but not to the extent of 2020 and 2021. Using 2017 as the base modeling year ensures that anthropogenic emissions are accurately reflected, speciation data are available and robust, and the model can more accurately reflect the impacts of control strategies; therefore, CARB is using 2017 as the base modeling year for the attainment demonstration. Selecting 2017 for the planning inventory base year would allow for more consistency across the planning and modeling inventories used in the 2023 PM2.5 Plan.

After consideration of all the above, CARB has determined that the 2017 base year inventory is technically appropriate for the San Joaquin Valley 2023 PM2.5 Plan since it is based on actual data, reflects typical emission conditions, can account for the benefits of a new rule related to residential wood burning, and is consistent with the modeling base year inventory.

5.3.2 Forecasted Inventories

In addition to base year emissions, emissions projections are needed for a variety of reasons, including redesignation maintenance plans, the attainment projected inventory for a nonattainment area (NAA), and air quality modeling for attainment plans[8].

For stationary and area sources, forecasted inventories are a projection of the base year inventory that reflects expected growth trends for each source category and emissions reductions due to adopted control measures. CARB develops emission forecasts by applying growth and control profiles to the base year inventory. The stationary and area source emissions inventories for the 2023 PM2.5 SIP are modeled by the California Emission Projection Analysis Model (CEPAM), 2022 PM2.5 Plans Emission Projections, Version 1.00.

Growth profiles for point and areawide sources are derived from surrogates, such as economic activity, fuel usage, population, and housing units, that best reflect the expected growth trends for each specific source category. Growth projections were obtained primarily from government entities with expertise in developing forecasts for specific sectors, or, in some cases, from econometric models. Control profiles, which account for emission reductions resulting from adopted rules and regulations, are derived

[8] 40 CFR 51.114. https://www.govinfo.gov/content/pkg/CFR-2000-title40-vol2/pdf/CFR-2000-title40-vol2-sec51-114.pdf.

from data provided by the regulatory agencies responsible for the affected emission categories.

Projections for on-road mobile source emissions are generated by CARB's EMFAC2021 model, which predicts activity rates and vehicle fleet turnover by vehicle model year, along with activity inputs from the metropolitan planning organizations (MPOs). Off-road mobile sources are forecasted with category-specific models or, where not available, CARB's OFFROAD2007. CEPAM integrates the emission projections derived from these mobile source models to develop a comprehensive forecasted emission inventory. As with stationary sources, the mobile source models include control algorithms that account for adopted regulatory actions.

5.3.3 Temporal Resolution

The 12 µg/m^3 NAAQS is an annual average standard; therefore, the emission inventory employed for this 2023 PM2.5 SIP is an annual average basis.

5.3.4 Quality Assurance and Quality Control

CARB has established a quality assurance and quality control (QA/QC) process to ensure the integrity and accuracy of the emission inventories used in the development of air quality plans. QA/QC occurs at the various stages of SIP emission inventory development. Base year emissions are assembled and maintained in the California Emission Inventory Development and Reporting System (CEIDARS). CARB inventory staff works with air districts, which are responsible for developing and reporting point source emission estimates, to verify these data are accurate. The locations of point sources, including stacks, are checked to ensure they are valid. Area-wide source emissions estimates are developed by both CARB and district staff, and the methodologies are reviewed by both agencies before their inclusion in the emissions inventory. Mobile categories are verified with CARB mobile source staff for consistency with the on-road and off-road emission models. Additionally, CEIDARS is designed with automatic system checks to prevent errors, such as double counting of emission sources. At the final stage, CEPAM is thoroughly reviewed to validate the accuracy of growth and control application, and the output emissions are compared against prior approved versions of CEPAM to identify data anomalies.

5.4 EMISSION INVENTORY COMPONENTS

A summary of the components that make up 2023 PM2.5 SIP emissions inventory is presented in the following sections. These include mobile (on- and off-road) sources, stationary point sources, areawide sources, and natural sources.

5.4.1 Mobile Source Emissions

CARB develops the emission inventory for the mobile sources using various modeling methods. These models account for the effects of various adopted regulations, technology types, fleet turnover, and seasonal conditions on emissions. Mobile sources in the emission inventory are composed of both on-road and off-road sources, described in the sections below.

On-Road Mobile Source Emissions

Emissions from on-road mobile sources, which include passenger vehicles, buses, and trucks, were estimated using outputs from CARB's EMFAC2021 v1.0.2 model. The on-road emissions were calculated by applying EMFAC2021 emission factors to the transportation activity data provided by the local MPOs based on the 2022 Regional Transportation Plan.

The EMFAC2021 model incorporates data on California's car and truck fleets, as well as travel activity. The light-duty motor vehicle fleet age, vehicle type, and vehicle population were updated based on 2019 California Department of Motor Vehicles (DMV) data. Moreover, the model also reflects the emissions benefits of CARB's recent rulemakings such as the Advanced Clean Trucks, Heavy-Duty Omnibus, as well as CARB's Truck and Bus Rule and previously adopted rules for other on-road diesel fleets.

EMFAC2021 utilizes a socio-econometric regression modeling approach to forecast new vehicle sales and to estimate future fleet mix. Light-duty passenger vehicle population includes 2019 DMV registration data along with updates to emission rates based on test data and the inclusion of plug-in hybrid electric vehicles. For heavy-duty vehicles, model year specific emission factors based on new test data were used, along with population estimates using DMV data for in-state trucks and International Registration Plan (IRP) data for out-of-state vehicles.

Additional information and documentation on the EMFAC2021 model are available at: https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/msei-road-documentation

EMFAC2021 Heavy-Duty Inspection and Maintenance Off-Model Adjustment

On December 9, 2021, CARB adopted the Heavy-Duty Inspection and Maintenance (HD I/M) program, which controls emissions effectively from non-gasoline on-road heavy-duty vehicles with a gross vehicle weight rating (GVWR) greater than 14,000 pounds. Starting from calendar year 2023, the program drastically reduces NOx and PM2.5 emissions by enforcing periodic testing and inspections for heavy-duty trucks operating in California.

The HD I/M regulation impacts some of the underlying assumptions in CARB's EMFAC2021 model, which was used to assess emissions from on-road mobile sources. Therefore, CARB developed off-model adjustment factors based on off-model analysis with EMFAC2021 to reflect the regulation. More information on this analysis is provided in Appendix D of the HD I/M staff report. Since this regulation was adopted after the release of EMFAC2021, these adjustment factors were calculated based on emission estimates under two scenarios: (1) EMFAC2021 default, plus HD I/M factors applied; and (2) EMFAC2021 default, which is the baseline before HD I/M. These adjustments, provided in the form of multipliers, were applied to emissions outputs from the EMFAC2021 model by the CEPAM external adjustment module to account for the impact of HD I/M. These off-model adjustment factors were applied to all heavy-duty diesel categories.

EMFAC2021 Advanced Clean Cars II

On November 30, 2022, CARB adopted Advanced Clean Cars II (ACC II), which requires all light-duty cars, trucks, and SUVs sold in California be zero emission vehicles by 2035. ACC II will be implemented in 2026 and is projected to substantially reduce NOx, PM2.5, and ROG emissions by decreasing the number of internal combustion engines in the light-duty fleet.

ACC II impacts some of the underlying assumptions in CARB's EMFAC2021 model, which was used to assess emissions from on-road mobile sources. Therefore, CARB developed off-model adjustment factors based on off-model analysis with EMFAC2021 to reflect the regulation. More information on this analysis is provided in Appendix D of the ACC II staff report. Since this regulation was adopted after the release of EMFAC2021, these adjustment factors were calculated based on emission estimates under two scenarios: (1) EMFAC2021 default, plus ACC II factors applied; and (2) EMFAC2021 default, which is the baseline before ACC II. These adjustments, provided in the form of multipliers, were applied to emissions outputs from the EMFAC2021 model by the CEPAM external adjustment module to account for the impact of ACC II. These off-model adjustment factors were applied to all light-duty categories.

5.4.2 Off-Road Mobile Source Emissions

Emissions from off-road sources are estimated using a suite of category-specific models or, where a new model was not available, the OFFROAD2007 model. Many of the newer models are developed to support recent regulations, including in-use off-road equipment, ocean-going vessels, and others. The sections below summarize the updates made by CARB to specific off-road categories.

Recreational Marine Vessels

Pleasure craft or recreational marine vessel (RMV) is a broad category of marine vessel that includes gasoline-powered spark-ignition marine watercraft (SIMW) and diesel-powered marine watercraft. It includes outboards, sterndrives, personal watercraft, jet boats, and sailboats with auxiliary engines. This emissions inventory was last updated in 2014 to support the evaporative control measures. The population, activity, and emission factors were revised using new surveys, DMV registration information, and emissions testing.

Staff used economic data from a 2014 UCLA Economic Forecast to estimate the near-term annual sales of RMV (2014 to 2019). To forecast long-term annual sales (2020 and later), CARB staff used an estimate of California's annual population growth as a surrogate.

Additional information is available at:
https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/road-documentation/msei-documentation-offroad

Recreational Vehicles

Off-highway recreational vehicles include off-highway motorcycles (OHMC), all-terrain vehicles (ATV), off-road sport vehicles, off-road utility vehicles, sand cars, golf carts, and snowmobiles. A new model was developed in 2018 to update emissions from recreational vehicles. Input factors such as population, activity, and emission factors were re-assessed using new surveys, DMV registration information, and emissions testing. OHMC population growth is determined from two factors: incoming population as estimated by future annual sales and the scrapped vehicle population as estimated by the survival rate.

Additional information is available at:
https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/road-documentation/msei-documentation-offroad

Fuel Storage and Handling

Emissions from portable fuel containers (gas cans) were estimated based on past surveys and CARB in-house testing. This inventory uses a composite growth rate that depends on occupied household (or business units), percent of households (or businesses) with gas cans, and average number of gas cans per household (or business) units.

Additional information is available at:
https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/road-documentation/msei-documentation-offroad

Small Off-Road Engines (SORE)

Small off-road engines (SORE) are spark-ignition engines rated at or below 19 kilowatts (i.e., 25 horsepower). Typical engines in this category are used in lawn and garden equipment as well as other outdoor power equipment and cover a broad range of equipment. The majority of this equipment belongs to the Lawn & Garden (e.g., lawnmower, leaf blower, trimmer) and Light Commercial (e.g., compressor, pressure washer, generator) categories of CARB's SORE emissions inventory model.
The newly developed, stand-alone SORE2020 Model reflects the recovering California economy from the 2008 economic recession and incorporates emission results from CARB's recent in-house testing as well as CARB's most recent Certification Database. CARB also has conducted an extensive survey of SORE operating within California through the Social Science Research Center (SSRC) at the California State University, Fullerton (CSUF). Data collected through this survey provides the most up-to-date information regarding the population and activity of SORE equipment in California. The final SORE emissions included the adopted SORE rule in December 2021 as well as the

15-day changes after the CARB hearing which allowed the pressure washers (greater than 5 hp) extra time for meeting the regulation. The SORE annual sales were forecasted using historic growth of the number of California households (DOF household forecasts, 2000 – 2008 and 2009 - 2018).

Additional information on SORE baseline emissions (without the adopted rule and 15-day changes) is available at:
https://ww2.arb.ca.gov/sites/default/files/2020-09/SORE2020_Technical_Documentation_2020_09_09_Final_Cleaned_ADA.pdf

Ocean Going Vessels

Ocean going vessels (OGVs) were updated in 2021 based on AIS (transponder) data. This data, along with vessel information supplied by South Coast AQMD and IHS Fairplay provides vessel visit counts, speed, engine size, and other vessel characteristics. The inventory adopts US EPA's methodology for emissions based on vessel speed, engine model year and horsepower. The inventory includes transit, maneuvering, anchorage and at-berth emissions, updating the 2019 at-berth-only inventory. The comprehensive national model Freight Analysis Framework (FAF) was used to develop growth rates for forecasting.

Additional information on CARB's general OGV update is available at:
https://ww2.arb.ca.gov/sites/default/files/2022-03/CARB_2021_OGV_Documentation_ADA.pdf

Commercial Harbor Craft

Commercial Harbor Crafts (CHC) are grouped into 18 vessel types: articulated tug barge (ATB), bunker barge, towed petrochemical barge, other barge, dredge, commercial passenger fishing, commercial fishing, crew and supply, catamaran ferry, monohull ferry, short run ferry, excursion, ATB tug, push and tow tug, escort/ship assist tug, pilot boat, research boat, and work boat.

The CHC inventory was updated in 2021 and includes vessels used around harbors such as tug and tow boats, fishing vessels, research vessels, barges, and similar. The inventory was updated based on CARB's reporting data for these vessels, as well as inventories from the Ports of Los Angeles and Long Beach and Oakland and Richmond. This supplied vessel characteristics, and the population was scaled up to match U.S. Coast Guard data on the annual number of vessels in California waters. Activity and load factors were based on a mix of reporting data and port-specific inventories. Emission factors were based on certification data for harbor craft engines. Population and activity growth factors were estimated based on historical trends in the past decade.

Additional information on this methodology is available at:
https://ww2.arb.ca.gov/sites/default/files/barcu/regact/2021/chc2021/apph.pdf

Locomotives

All locomotive inventories were updated in 2020 and include linehaul (large national companies), switchers (used in railyards), passenger, and Class 3 locomotives (smaller regional companies). Data for each sector was supplied by rail operations, including Union Pacific and Burlington Northern, and Santa Fe Railway (BNSF) for linehaul and switcher operations. Data for other categories was supplied by the locomotive owners. Emission factors for all categories were based on U.S. EPA emission factors for locomotives. The inventory reflects the 2005 memorandum of understanding (MOU) with Union Pacific and BNSF. Growth rates were primarily developed from the FAF.

More information is available at:
https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/road-documentation/msei-documentation-road

Military and Industry Locomotives

This new category includes military and Industrial (M&I) locomotive emission inventory and relies on the annual fuel consumption and engine information collected from 2011 to 2018. The M&I locomotive data was supplied by 39 private companies and 4 military rail groups, with a total of 85 locomotives. The subject locomotives typically consist of smaller, older switchers and medium horsepower (MHP, 2,301 to 3,999 hp) locomotives operating within the boundaries of a granary, plant, or industrial facility.

The methodology is available at:
https://ww2.arb.ca.gov/sites/default/files/2022-07/2022%20MI%20Locomotive%20Emission%20Inventory%20Document%2007112022%20ADA%20Checked.pdf

Diesel Agricultural Equipment

The agricultural equipment inventory covers all off-road vehicles used on farms or first processing facilities (of all fuel types). It was updated in 2021 using a 2019 survey of California farmers and rental facilities, and the 2017 U.S. Department of Agriculture (USDA) agricultural census. Emission factors are based on the 2017 off-road diesel emission factor update. The inventory reflects incentive programs for agricultural equipment that were implemented earlier than August 2019. Agricultural growth rates were developed using historical data from the County Agricultural Commissioners' reports.

Additional information is available at:
https://ww2.arb.ca.gov/sites/default/files/2021-08/AG2021_Technical_Documentation_0.pdf

In-Use Off-Road Equipment

This category covers off-road diesel vehicles over 25 horsepower in construction, mining, industrial, and oiling drilling categories. The inventory was updated in 2022 based on the DOORS registration program. Activity was updated based on a 2021 survey of registered equipment owners, and emission factors were based on the 2017 off-road diesel emission factor update. The inventory reflects the In-Use Off-Road Equipment Regulations, as amended in 2011.

The methodology is available at:
https://ww2.arb.ca.gov/sites/default/files/2022-10/2022InUseDieselInventory.pdf

Cargo Handling Equipment

The Cargo Handling Equipment (CHE) inventory covers equipment (of all fuels) used at California ports and intermodal railyards, such as cranes, forklifts, container handling equipment, and more. The inventory population and activity were updated in 2021 based on the port inventories for the Ports of Los Angeles and Long Beach and Richmond, and the CARB reporting data for other ports and railyards, which had a more comprehensive inventory than available through reporting. Load factors were based on the previous inventory in 2007, and emission factors were based on the 2017 off-road diesel emission factor update. The inventory reflects the CHE Airborne Toxic Control Measures (ATCM), adopted in 2005 and completed in 2017.

The updated methodology is currently in the process of being posted online. When it is completed, the methodology will be available at:

https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/road-documentation/msei-documentation-road

Transportation Refrigeration Units

The Transportation Refrigeration Units (TRU) inventory was updated in 2020 based on the TRU reporting program at CARB. The activity was developed based on 2010 surveys of facilities served by TRUs and 2017 to 2019 telematics data purchased from TRU manufacturers. Emission factors were developed specifically for TRUs based on TRU engine certification data reported to U.S. EPA as of 2018. The inventory reflects the TRU ATCM and 2021 amendments. Forecasting was based on IBISWorld reports forecast for related industries, and turnover forecasting was based on the past 20 years equipment population trends.

Additional information is available at:
https://ww2.arb.ca.gov/sites/default/files/barcu/board/rulemaking/tru2021/apph.pdf

Portable Equipment

Portable equipment inventory includes non-mobile diesel, such as generators, pumps, air compressors, chippers, and other miscellaneous equipment over 50 horsepower. This inventory was developed in 2017 based on CARB's registration program, 2017 survey of registered owners for activity and fuel, and the 2017 off-road diesel emission factor update. The inventory also reflects the Portable ATCM and 2017 amendments.

Because registration in Portable Equipment Registration Program (PERP) is voluntary, the PERP registration data was used as the basis for equipment population, with an adjustment factor used to represent the remaining portable equipment in the state. Estimates of future emissions beyond the base year were made by adjusting base year estimates for population growth, activity growth, and the purchases of new equipment (i.e. natural and accelerated turnover).

Additional information is available at:
https://ww3.arb.ca.gov/msei/ordiesel/perp2017report.pdf

Large Spark Ignition/Forklifts

The large spark ignition (LSI) inventory includes gasoline and propane forklifts, sweeper/scrubbers, and tow tractors. The inventory was updated in 2020 based on the LSI/forklift registration in the DOORS reporting system at CARB, and the sales data was provided by the Industrial Truck Association (ITA). Activity was based on a survey of equipment owners in the DOORS system, and emission factors were based on U.S. EPA's latest guidance for gasoline and propane engines. The inventory reflects the LSI regulation requirements and 2016 amendments.
The updated methodology is currently in the process of being posted online. When it is completed, the methodology will be available at:
https://ww2.arb.ca.gov/our-work/programs/mobile-source-emissions-inventory/road-documentation/msei-documentation-road

Forestry Equipment

The new 2021 forestry diesel equipment emissions inventory was developed to replace the previous emissions inventory for diesel forestry equipment based on OFFROAD2007. This inventory includes equipment used in forestry and in milling. This includes foresting operations, such as feller/bunchers and dragline operations, equipment used to build roads to reach forested areas, and forklifts or loaders used in milling operations. The inventory was based on a 2019 survey of forestry operations and mills (for calendar year 2017), as well as the 2019 California Department of Tax and Fee Administration data on the annual timber harvest, with emission factors from the 2017 off-road diesel emission factor update. This sector does not include any emission reduction measures or strategies. The model projects forestry equipment population and emissions in future years by predicting the retirement and purchasing habits of forestry equipment. The model attempts to predict a business as usual (BAU) behavior based on the 2017 survey data.

Additional information is available at:
https://ww2.arb.ca.gov/sites/default/files/2021-10/2021_Forestry_Inventory_Technical_Document_FINAL_09302021.pdf

5.4.3 Stationary Point and Stationary Aggregated Sources

The stationary source inventory is composed of point sources and area-wide sources. The data elements in the inventory are consistent with the data elements required by the AERR. The inventory reflects actual emissions from industrial point sources reported to the District by the facility operators through calendar year 2017.

More information regarding the District's facility point source inventory is available at:
https://www.valleyair.org/busind/pto/Tox_Resources/emissions_inventory.htm

Stationary point sources also include smaller point sources, such as gasoline dispensing facilities and laundering, that are not inventoried individually, but are estimated as a group and reported as a single source category, Stationary Aggregated. Emissions from these sources are estimated using various models and methodologies. Estimation methods include source testing, direct measurement by continuous emissions monitoring systems, or engineering calculations. Emissions for these categories are estimated by both CARB and the District.

The District's methodologies are available at:
http://www.valleyair.org/Air_Quality_Plans/EmissionsMethods/EmissionsMethods.htm

Estimates for the categories below were developed by CARB and have been reviewed by CARB staff to reflect the most up-to-date information.

Stationary Nonagricultural Diesel Engines

This category includes emissions from backup and prime generators and pumps, air compressors, and other miscellaneous stationary diesel engines that are widely used throughout the industrial, service, institutional, and commercial sectors. The emission estimates, including emission forecasts, are based on a 2003 CARB methodology derived from the OFFROAD2007 model.

Additional information on this methodology is available at:
https://ww3.arb.ca.gov/ei/areasrc/arbfuelcombother.htm

Agricultural Diesel Irrigation Pumps

This category includes emissions from the operation of diesel-fueled stationary and mobile agricultural irrigation pumps. The emission estimates are based on a 2003 CARB methodology using statewide population and include replacements due to the Carl Moyer Program. Emissions are grown based on projected acreage for irrigated farmland from the California Department of Conservation's Farmland Mapping and Monitoring Program (FMMP), 2008.

Additional information on this category is available at:
https://ww3.arb.ca.gov/ei/areasrc/fullpdf/full1-1.pdf

Wine Fermentation and Aging

This category includes emissions from the fermentation and aging of wine. Wine fermentation volumes in California are reported by the U.S. Alcohol and Tobacco Tax and Trade Bureau. CARB staff derived the emission factors from a computer model developed by Williams and Boulton. Emissions were initially estimated for 2002 and grown to later years using beverage manufacturing (Alcoholic & Non-Alcoholic) economic output.

An emission factor for brandy was derived by Hugh Cook of the Wine Institute. Emissions were initially estimated for 1992 then grown to 2012 using economic output for food manufacturing. Emissions were grown from 2012 to 2017 using beverage manufacturing economic output per Regional Economic Models, Inc. (REMI). Growth for future years is based on REMI forecast version 2.4.5.

Additional information on this methodology is available at:
http://www.arb.ca.gov/ei/areasrc/arbindprofandag.htm

Laundering

This category includes emissions from perchloroethylene (perc) dry cleaning establishments. The emission estimates are based on a 2002 CARB methodology that used nationwide perc consumption rates allocated to the county level based on population and an emission factor of 10.125 pounds per gallon used. Emissions were grown based on the California Department of Finance (DOF) population forecasts, 2020.

Additional information on this methodology is available at:
https://ww3.arb.ca.gov/ei/areasrc/arbcleanlaund.htm

Degreasing

This category includes emissions from solvents in degreasing operations in the manufacturing and maintenance industries. The emissions estimates are based on a 2000 CARB methodology using survey and industry data, activity factors, emission factors and a user’s fraction. Emissions were grown based on CARB/REMI industry-specific economic output, version 2.4.5.

Additional information on this methodology is available at:
https://ww3.arb.ca.gov/ei/areasrc/arbcleandegreas.htm

Coatings and Thinners

This category includes emissions from coatings and related process solvents. Auto refinishing emissions estimates are based on a CARB methodology using production data and a composite emission factor derived from a 2002 survey. These estimates were grown based on CARB's on-road mobile sources model version EMFAC2017. Estimates for industrial coatings emissions are based on a 1990 CARB methodology using production and survey data, and emission factors derived from surveys. Estimates for thinning and cleaning solvents are based on a 1991 CARB methodology, census data and a default emission factor developed by CARB. These estimates were grown based on REMI county economic forecasts, version 2.4.5.

Additional information on these methodologies is available at:
https://ww3.arb.ca.gov/ei/areasrc/arbcleancoatreproc.htm

Adhesives and Sealants

This category includes emissions from solvent-based and water-based solvents contained in adhesives and sealants. Emissions are estimated based on a 1990 CARB methodology using production data and default emission factors. Estimates were grown based on REMI county economic forecasts, version 2.4.5.

Additional information on this methodology is available at:
https://ww2.arb.ca.gov/carb-cleaning-and-surface-coating-methodologies-adhesives-and-sealants

Gasoline Dispensing Facilities

This category uses a 2015 CARB methodology to estimate emissions from fuel transfer and storage operations at gasoline dispensing facilities (GDFs). The methodology addresses emissions from underground storage tanks, vapor displacement during vehicle refueling, customer spillage, and hose permeation. The updated methodology uses emission factors developed by CARB staff that reflect more current in-use test data and also accounts for the emission reduction benefits of onboard refueling vapor recovery (ORVR) systems. The emission estimates are based on 2012 statewide gasoline sales data from the California Board of Equalization that were apportioned to the county level using fuel consumption estimates from EMFAC 2014. Emissions were grown based on the EMFAC2017 version model.

Additional information on this category is available at:
https://ww2.arb.ca.gov/arb-petroleum-production-and-marketing-methodologies-petroleum-marketing

Gasoline Cargo Tank

This category uses a 2002 CARB methodology to estimate emissions from gasoline cargo tanks. These emissions do not include the emissions from loading and unloading of gasoline cargo tank product; they are included in the gasoline terminal inventory and gasoline service station inventory. Pressure-related fugitive emissions are volatile organic vapors leaking from three points: fittings, valves, and other connecting points in the vapor collection system on a cargo tank. 1997 total gasoline sales were obtained from the California Department of Transportation. The emission factors are derived from the data in the report, "Emissions from Gasoline Cargo Tanks, First Edition," published by the Air and Waste Management Association in 2002.

The initial emission estimates for 1997 were grown to 2012 using a growth parameter developed by Pechan based on gasoline and oil expenditures data. Emissions were grown to 2017 and beyond according to fuel consumption from CARB's EMFAC 2017 mobile sources emission factors model.

Additional information on this methodology is available at:
https://ww2.arb.ca.gov/arb-petroleum-production-and-marketing-methodologies-petroleum-marketing

Marine Petroleum Loading

These categories are used to inventory 1987 hydrocarbon emissions associated with loading crude oil, residual oil, gasoline, and jet fuel into marine tankers and gasoline into barges. Emissions result from the displacement of vapors existing in the tank before loading and those generated as new product is loaded.

The amounts of crude oil, gasoline, jet fuel, and residual oil shipped off from California ports were obtained from a United States Army Corps of Engineers report "Waterborne Commerce of the United States, Calendar Year 1986" Part 4.

The emission factor for crude oil loading into tankers was obtained from the report "Hydrocarbon Emissions During Marine Loading of Crude Oils" from Western Oil and Gas Association (1977). The gasoline emission factors for loading into tankers and barges and jet fuel into tankers were obtained from CARB's "Report to the Legislature on Air Pollutant Emissions from Marine Vessels" (1984). The emission factor for residual oil loading into tankers was obtained from the "Inventory of Emissions from Marine Operations within California Coastal Waters, Preliminary Draft" report by Scott Environmental Technology, Inc. (1980). No growth was assumed for these emissions.

Additional information on this methodology is available at:
https://ww2.arb.ca.gov/arb-petroleum-production-and-marketing-methodologies-petroleum-marketing

Marine Petroleum Unloading

These categories are used to estimate hydrocarbon emissions associated with lightering crude oil and ballasting marine vessels after unloading crude oil or gasoline.

The amounts of crude oil and gasoline unloaded at California ports were obtained from the United States Army Corps of Engineers report "Waterborne Commerce of the United States, Calendar Year 1986" Part 4.

Crude oil lightering data was obtained from the Bay Area AQMD for 1987. Crude oil and gasoline ballasting data for San Luis Obispo for 1987 was obtained from the Army Corps of Engineers. The volume of water used for ballasting following a cargo discharge was obtained from CARB's "Report to the Legislature on Air Pollutant Emissions from Marine Vessels" (1984).

The crude oil lightering emission factor was obtained from "Hydrocarbon Emissions During Marine Loading of Crude Oils," Western Oil and Gas Association (1977).

Ballasting crude oil and gasoline vessels emission factors were obtained from "Inventory of Emissions from Marine Operations within the California Coastal waters," by Scott Environmental Technology, Inc. (1981). No growth is assumed for this category.

Additional information on this methodology is available at:
https://ww2.arb.ca.gov/arb-petroleum-production-and-marketing-methodologies-petroleum-marketing

Oil and Gas Production

The oil and natural gas production inventory is estimated by a 2015 CARB methodology. This category is related to fugitive emissions from production-related fuel consumption, fugitive losses (sumps, pits, pumps, compressors, well heads, separators, valves, and fittings), vapor recovery and flares, tank and truck working and breathing losses, wastewater treatment, tertiary production, and wet and dry gas stripping. Emissions were calculated using U.S. EPA's Oil and Natural Gas Tool v1.4 with default emissions factors from ENVIRON Int'l Corp's 2012 report, "2011 Oil and Gas Emission Inventory Enhancement Project for CenSARA States," and activity data taken from California's Division of Oil, Gas, and Geothermal Resources (DOGGR) (which was renamed to Geologic Energy Management Division (CalGEM) in 2020). CARB also incorporated data from the 2007 Oil and Gas Industry Survey (e.g., typical component counts) and feedback from individual air districts (e.g., minimum controls required to operate in a certain district, with associated control factors) to improve these parameters and further adjust the tool's output. Emissions were grown to 2017 based on CalGEM historical statewide production. Growth in future years an assumed 2.9% annual decline, which reflects the statewide CalGEM trend from 2000 through 2016.

Additional information on this methodology is available at:
https://ww2.arb.ca.gov/resources/documents/oil-and-gas-industry-survey
https://ww3.arb.ca.gov/ei/areasrc/oilandgaseifinalreport.pdf

5.4.4 Area-Wide Sources

Area-wide sources include categories where emissions take place over a wide geographic area, such as consumer products. Emissions from these sources are estimated using various models and methodologies. Estimation methods include source testing, direct measurement by continuous emissions monitoring systems, or engineering calculations. Emissions for these categories are estimated by both CARB and the District.

The District's methodologies are available at:
http://www.valleyair.org/Air_Quality_Plans/EmissionsMethods/EmissionsMethods.htm

Estimates for the categories below were developed by CARB and have been reviewed by CARB staff to reflect the most up-to-date information:

Consumer Products and Aerosol Coatings

The Consumer Product emission estimates utilized sales and formulation data from the CARB's mandatory survey of all consumer products sold in California for calendar years 2013 through 2015 (2015 Consumer Product Survey). The aerosol coatings estimates utilized sales and formulation data from a survey conducted by CARB in 2010. Based on the survey data, CARB staff determined the total product sales and total VOC emissions for the various product categories. Growth for personal care products are based on real disposable personal income projections per REMI version 2.4.5. No growth is assumed for aerosol coatings. Growth for all other consumer products are based on DOF population projections, 2020.

Additional information on CARB's consumer products surveys is available at:
https://ww2.arb.ca.gov/our-work/programs/consumer-products-program/consumer-commercial-product-surveys

The methodology is available at:
Solvent Evaporation Methodologies - Aerosol Coatings and Consumer Products | California Air Resources Board

Architectural Coatings

Architectural coatings are coatings applied to stationary structures and their accessories. They include house paints, stains, industrial maintenance coatings, traffic coatings, and many other products. Industrial maintenance coatings are high performance architectural coatings formulated for application to substrates, including floors, exposed to extreme environmental conditions (e.g., immersion in water, chronic exposure to corrosive agents, frequent exposure to temperatures above 121°C, repeated heavy abrasion). The architectural coatings category reflects emission estimates based on a 2014 comprehensive CARB survey for the 2013 calendar year. The emission estimates include benefits of the 2007 CARB Suggested Control Measures. These emissions are grown based on DOF households forecast, 2020.

Additional information about CARB's architectural coatings program is available at: https://ww2.arb.ca.gov/carb-solvent-evaporation-methodologies-architectural-coatings-and-cleaningthinning-solvents

Pesticides

The California Department of Pesticide Regulation (DPR) develops month-specific emission estimates for agricultural and structural pesticides. Each calendar year, DPR updates the inventory based on the Pesticides Use Report, which provides updated information from 1990 through the 2020 calendar year. Agricultural pesticide emission forecasts for years 2021 and beyond are based on the average of the most recent five years. Growth for agricultural pesticides is based on CARB projections of farmland acres per FMMP, 2016. Growth for structural pesticides is based on DOF households growth projections, 2020.

Additional information about CARB's pesticides program is available at: https://ww2.arb.ca.gov/carb-solvent-evaporation-methodologies-agricultural-and-non-agricultural-pesticides

Residential Wood Combustion

Emissions were estimated for 2012 using a 2015 District methodology. The methodology is based on CARB's 2011 methodology, with several refinements based on a 2014 District survey. The inventory reflects the regional distribution and use of wood burning devices, refined fuel usage rates for several types of devices, and emissions reductions from the District's Burn Cleaner Program. The emissions estimates reflect emission factors from U.S. EPA's 2002 National Emission Inventory (NEI). CARB assumes no growth for this category based on the relatively stagnant residential wood fuel use over the past decade (according to the American Community Survey and US Energy Information Administration).

Additional information on CARB's 2011 methodology is available at: https://ww2.arb.ca.gov/carb-miscellaneous-process-methodologies-residential-fuel-combustion

Residential Natural Gas Combustion

CARB staff updated the methodology to reflect 2017 fuel use from the California Energy Consumption Database. The emissions estimates reflect the most recent emissions factors from U.S. EPA's AP-42 for residential natural gas combustion. Growth is based on California Energy Commission (CEC) projections for natural gas consumption, 2019.

Additional information on this methodology is available at:
https://ww2.arb.ca.gov/carb-miscellaneous-process-methodologies-residential-fuel-combustion

Residential Distillate Oil and Liquefied Petroleum Gas

The residential distillate oil/liquefied petroleum gas (LPG) category includes emissions occurring in the residential sector. Distillate oil for heating is generally used in older homes and remote areas where natural gas lines are not available.

Activity is based on the number of housing units, population, and LPG and distillate oil capacities. The 1991 Fuels Report Working Paper published by the CEC was used to determine energy demand by fuel type in terms of the number of houses heated by a specific fuel in a particular area. Heating degree days (HDD) are used to estimate how many heating days are likely to occur in a particular area.

This category uses emission factors from U.S. EPA's AP-42. The emissions were initially calculated in 1993 then grown to 2012 using housing unit data from the DOF, 2013. Emissions were grown from 2012 to 2017 using a ‘no growth’ profile developed by Pechan (2012). Emissions post-2017 were grown based on EIA – SEDS, and no growth was assumed.

Additional information on this methodology is available at:
https://ww2.arb.ca.gov/carb-miscellaneous-process-methodologies-residential-fuel-combustion

Farming Operations

Tilling and Harvesting:
Emissions for Agricultural Land Preparation Operations and Agricultural Harvest Operations were updated based on 2012 harvested crop acreage from the USDA’s National Agricultural Statistics Service (NASS). NASS data are based on reports compiled by County Agricultural Commissioner staff. Emission estimates for both categories are based on CARB methodologies and reflect crop and operation specific emission factors. Temporal profiles were updated based on crop specific activity profiles. Activity profiles for land preparation operations were developed by CARB, based on monthly harvesting activity for 20 representative crops. Temporal profiles for harvesting operations were developed by the District, based on monthly harvesting activity for 46 representative crops. The District expanded the number of crop profiles to more completely characterize distinctions among groups of crops.

Activity profiles for harvesting were developed by the District and reflect refinements to Harvesting Growth is based on farmland acres per FMMP farmland acreage which results in a slight annual decline. The inventory also reflects the emission reductions from District Rule 4550.

Livestock:
CARB staff updated the non-cattle Livestock Husbandry methodology to reflect livestock population data based on the USDA's 2017 Census of Agriculture. Cattle emissions are primarily based on the 2012 Census of Agriculture. A seasonal adjustment was added to account for the suppression of dust emissions in months in which rainfall occurs. Growth profiles are based on CARB's projections of Census of Agriculture's historical livestock population trends, 2012. No growth is assumed for dairy and feedlots.

Additional information on CARB's methodology for farming operations is available at: *https://ww2.arb.ca.gov/carb-miscellaneous-process-methodologies-farming-operations*

Construction and Demolition

Emission estimates for building construction and road construction operations are based on CARB methodologies. Emissions are estimated by applying emission factors developed by Midwest Research Institute (MRI) to the acreage disturbed by construction.

For building construction, the emission estimates in 2017 were grown from CARB estimates developed in 2002. The growth profile for building construction is based on construction jobs projections from the REMI county economic forecast model.

For road construction, the 2017 emissions were updated based on the average of lane miles constructed between 2005 and 2019 based on the 2019 FTIP data provided by the SJV transportation planning agencies (TPAs). The growth profile for road construction is based on the future planned construction from the 2019 FTIP.

The inventory reflects emission reductions from District Regulation VIII. Additional information on these methodologies is available at:
https://www.arb.ca.gov/ei/areasrc/arbmiscprocconstdem.htm

Paved Road Dust

Paved road dust emissions for 2017 were estimated in 2021 using a CARB methodology consistent with the current U.S. EPA method (AP-42). Data from CARB's EMFAC2017 model, the District, and the Valley MPOs were used to estimate region specific vehicle miles traveled (VMT). VMT were distributed using 2017 travel fractions calculated using California Department of Transportation (Caltrans) Highway Performance Monitoring System (HPMS) data, by COADBIS, for each of five road types: freeway, major, collector, and local/local urban, and local rural. Emissions were grown using MPO VMT projections.

Additional information on this methodology is available at:
https://ww2.arb.ca.gov/carb-miscellaneous-process-methodologies-paved-road-dust

Unpaved Road Dust – Farm Roads

Emissions for unpaved farm roads are based on CARB's methodology and 2012 harvested crop acreage from NASS. Emissions reflect crop specific VMT rates and an emission factor based on California test data conducted by the University of California, Davis (UC Davis), and the Desert Research Institute (DRI). Temporal profiles are based on crop specific activity profiles. Growth for this category is based on projected FMMP farmland acreage, 2016.

Additional information on this methodology is available at:
https://ww3.arb.ca.gov/ei/areasrc/fullpdf/full7-11_2016.pdfe

Unpaved Nonfarm Road Dust

Emissions from unpaved nonfarm roads were estimated from 2008 unpaved road data collected from the California Statewide Local Streets and Roads Needs Assessment, Caltrans, and local agencies. Dust emissions were calculated using an emission factor derived from tests conducted by UC Davis and DRI. In addition, a rainfall adjustment factor was applied. CARB staff assumed no growth for this category based on the assumption that existing unpaved roads tend to get paved as vehicle traffic on them increases, which counteracts any additional emissions from new unpaved roads.

Additional information on this methodology is available at:
https://ww3.arb.ca.gov/ei/areasrc/fullpdf/full7-10_2012.pdf

Fugitive Windblown Dust from Agriculture Lands (Non-Pasture) and Pasture Lands

Fugitive windblown dust emissions were estimated using CARB's 1997 methodology. The methodology is based on 1993 harvested crop acreage and a wind erosion equation that incorporates climate, soil, and vegetative cover attributes. Emissions for agricultural lands were grown based on projections of acreage from FMMP Acreage, 2016. Emissions for pasture lands were grown from FMMP Grazing, 2016.

Additional information on this methodology is available at:
https://ww3.arb.ca.gov/ei/areasrc/onehtm/one7-12.htm

Windblown Dust from Unpaved Roads and Associated Areas

Emissions for this source category were estimated based on a 1997 CARB methodology reflecting unpaved road mileage and local parameters that affect wind erosion. The estimates assume no growth.

Additional information on this methodology is available at:
https://ww3.arb.ca.gov/ei/areasrc/onehtm/one7-13.htm

Fires

Emissions from structural and automobile fires were estimated based on a 1999 CARB methodology using the number of fires and the associated emission factors. Estimates for structural fires are calculated using the amount of the structure that is burned, the amount and content of the material burned, and emission factors derived from test data. Estimates for automobile fires are calculated using the weight of the car and components and composite emission factors derived from AP-42 emission factors. Structural fire growth is based on DOF households forecasts, 2020, and automobile fire growth is based on DOF population forecasts, 2020.

Additional information on this methodology is available at:
https://ww2.arb.ca.gov/carb-miscellaneous-process-methodologies-fires

Managed Burning & Disposal – Forest Management

Forest Management Managed Burning and Disposal category provides emission estimates from prescribed burning performed in natural vegetation types such as forests and woodlands.

Burn project perimeters and ignition dates are provided by the 2019 California Department of Forestry and Fire Protection (FRAP) geodatabase. Forest management prescribed burning emissions are estimated using the First Order Fire Effects Model (FOFEM 6.7) and a custom geoprocessing tool (Emission Estimation System, EES) developed for CARB by researchers at UC Berkeley. Future year estimates are based on a 10-year average, held flat in the forecast.

Additional information on this methodology is available at:
https://ww2.arb.ca.gov/district-miscellaneous-process-methodologies-managed-burning-and-disposal

Managed Burning & Disposal – Range Improvement

The Range Improvement Managed Burning and Disposal category provides emission estimates from prescribed burning performed in natural vegetation types (principally grasslands) for the purpose of forage or habitat improvement. Burn project parameters and ignition dates are provided by the 2019 California Department of Forestry and Fire Protection (FRAP) geodatabase. Range Improvement prescribed burning emissions are estimated using the First Order Fire Effects Model (FOFEM 6.7) and a custom geoprocessing tool (Emission Estimation System, EES) developed for CARB by researchers at UC Berkeley. Future year estimates are based on a 10-year average, held flat in the forecast.

Additional information on this methodology is available at:
https://ww2.arb.ca.gov/district-miscellaneous-process-methodologies-managed-burning-and-disposal

5.4.5 Natural Sources

Biogenic Vegetation (ROG) and Soil (NOx)

Biogenic emissions were generated using the Model of Emissions of Gases and Aerosols from Nature (MEGAN3.0) biogenics emissions model (https://bai.ess.uci.edu/megan). MEGAN3.0 incorporates a new pre-processor (MEGAN-EFP) for estimating biogenic emission factors based on available landcover and emissions data. The MEGAN3.0 default datasets for plant growth form, eco-type, and emissions were utilized. Leaf Area Index (LAI) for non-urban grid cells was based on the 8-day 500 m resolution Moderate Resolution Imaging Spectroradiometer (MODIS) Terra/Aqua combined product (MCD15A2H) for 2017 (https://earthdata.nasa.gov/). The LAI data was converted to LAIv, which represents the LAI for the vegetated fraction within each grid cell, by dividing the gridded MODIS LAI values by the Maximum Green Vegetation Fraction for each grid cell (https://archive.usgs.gov/archive/sites/landcover.usgs.gov/green_veg.html). The MODIS LAI product does not provide information on LAI in urban regions, so urban LAIv was estimated from the US Forest Service's Forest Inventory and Analysis urban tree plot data, processed through the i-Tree v6 software (*https://www.itreetools.org/tools/i-tree-eco*). Hourly meteorology for MEGAN was provided by the 4 km WRF simulation described above, and all stress factor adjustments were turned off.

MEGAN implemented the parameterized scheme Yiener-Levy (YL95) to estimate soil NOx (Yienger et al., 1995). Main features include separate exponential temperature dependence for wet soils and linear dependence for dry soils. An optimal temperature above which flux becomes temperature independent, scalar adjustments to account for both "pulsing" and canopy reduction, synoptic-scale temperature and precipitation forcing, an explicit linear dependence of emission on fertilizer rate.

References:
Guenther, A. B., X. Jiang, C. L. Heald, T. Sakulyanontvittaya, T. Duhl, L. K. Emmons, and X. Wang (2012). The Model of Emissions of Gases and Aerosols from Nature version 2.1 (MEGAN2.1): an extended and updated framework for modeling biogenic emissions, *Geosci. Model Dev.*, *5*(6), 1471-1492.

Guenther, A., Huang, L., Shah, T., Wentland, A., Jung, J., Beardsley, R., Johnson, J., Hsieh, W., Kemball-cook, S., and Yarwood, G. (2017). A Next Generation Modeling System for Estimating Texas Biogenic VOC Emissions. (AQRP Project 16-011).

Yienger, J. and Levy, H.: Empirical model of global soil-biogenic NOx emissions, J. Geophys. Res.-Atmos., 100, 11447–11464, 1995.

Wildfires

The wildfires category provides emission estimates from wildfires that occurred in natural vegetation types such as forests, woodlands, shrublands and grasslands.

Wildfire perimeters and ignition dates are provided by the 2019 California Department of Forestry and Fire Protection (FRAP) geodatabase. Wildfire emissions are estimated using the First Order Fire Effects Model (FOFEM 6.7) and a custom geoprocessing tool (Emission Estimation System, EES) developed for CARB by researchers at UC Berkeley. Future year estimates are based on a 10-year average, held flat in the forecast.

Additional information on this methodology is available at:
https://ww2.arb.ca.gov/carb-natural-non-anthropogenic-source-methodologies-wildfires

5.4.6 Point and Areawide Source Emissions Forecasting

Emission forecasts (2018 and subsequent years) are based on growth profiles that in many cases incorporate historical trends up to the base year or beyond. The growth surrogates used to forecast the emissions from these categories are presented below in Table 5-1. The emissions inventory also reflects emission reductions from point and areawide sources subject to District rules and CARB regulations. The rules and regulations reflected in the inventory are listed below in Table 5-2.

Table 5-1 Growth Surrogates for Point and Areawide Sources

Source Category	Subcategory	Growth Surrogate
Electric Utilities	Natural Gas	California Energy Commission (CEC) Integrated Energy Policy Report forecast, 2019
	Other Fuels	Energy Information Administration (EIA) Annual Energy Outlook, 2019
Cogeneration	All	CEC forecast, 2019
Oil and Gas Production (Combustion)	All	CalGEM statewide total oil production. Assumed 2.9% annual decline reflecting CalGEM historical trend, 2000 through 2016
Petroleum Refining (Combustion)	All	No growth assumption
Manufacturing and Industrial	Natural Gas	CEC forecast, 2019
	Other Fuels	EIA forecast, 2018
Food and Agricultural Processing	Ag Irrigation I. C. Engines	FMMP irrigated farmland acreage, 2008
	Natural Gas	CEC forecast, 2019
	Others	REMI economic forecast, version 2.4.5; EIA forecast, 2018
Service and Commercial	Natural Gas	CEC forecast, 2019
	Other Fuels	EIA forecast, 2018
Other (Fuel Combustion)	Diesel	Modeled estimate, 2003
	Other than diesel	EIA forecast, 2018
Waste Disposal	All	DOF population forecast, 2020
Laundering	Dry Cleaning	DOF population forecast, 2020
Degreasing	All	CARB/REMI economic forecast, version 2.4.5
Coatings & Thinners	Auto Refinishing	Vehicles from CARB EMFAC2017 model
	Others	REMI economic forecast, version 2.4.5
Printing	All	REMI economic forecast, version 2.4.5
Adhesives & Sealants	All	REMI economic forecast, version 2.4.5
Oil and Gas Production	All	Assumed 2.9% annual decline reflecting CalGEM historical trend, 2000 through 2016
Petroleum Refining	All	No growth assumption
Petroleum Marketing	Natural Gas Transmission	CEC forecast, 2019
	Gas Dispensing Facilities and Cargo Tanks	Fuel use from CARB EMFAC2017 model

Source Category	Subcategory	Growth Surrogate
	Other Point Sources	REMI economic forecast, version 2.4.5
Chemical	All	REMI economic forecast, version 2.4.5
Food & Agriculture	All	REMI economic forecast, version 2.4.5
Mineral Processes	All	REMI version 2.4.5; EIA forecast, 2018
Metal Processes	All	REMI economic forecast, version 2.4.5
Glass and Related Products	Container Glass, Other Glass	No growth assumption
	Flat Glass	Modeled estimate, 2012
Other Industrial Processes	All	REMI economic forecast, version 2.4.5
Consumer Products	Personal Care Products	Real Disposable Personal Income per REMI, version 2.4.5
	Other Consumer Products	DOF population forecast, 2020
	Aerosol Coatings	No growth
Architectural Coatings & Related Process Solvents	All	DOF households forecast, 2020
Pesticides & Fertilizers	Agricultural Pesticides	CARB projection of farmland acres per FMMP, 2016
	Structural Pesticides	DOF households forecast, 2020
Asphalt Paving & Roofing	All	DOF construction jobs forecast, 2020; CARB projection
Residential Fuel Combustion	Natural Gas	CEC forecast, 2019
	Other Fuels	EIA – SEDS – No growth
Farming Operations	Tilling and Harvesting	CARB projection of farmland acres per FMMP, 2016
	Dairy / Feedlots	No growth
	Other Livestock	CARB projection of livestock population per Census of Agriculture, 2012
Construction and Demolition	Building Construction	MI economic forecast, version 2.4.5
	Road Construction	MPOs / 2019 FTIP Planned Lane Miles

Source Category	Subcategory	Growth Surrogate
Paved Road Dust	All	MPO VMT projections, 2019
Unpaved Road Dust	City and County Roads, U.S. Forest, B.L.M	No Growth
	Farm Roads	FMMP Acreage, 2016
Fugitive Windblown Dust	Agricultural Lands (Non-Pasture	FMMP Acreage, 2016 FMMP Grazing, 2016
Fires	Structural	DOF households forecast, 2020
	Automobile	DOF population forecast, 2020
Managed Burning and Disposal	Agricultural Burning, Pruning & Field Crops	FMMP farmland acreage projection, 2016
	Non-Agricultural Open Burning	Rural counties: DOF population forecast, 2020. Urban counties: no growth.
	Unspecified Waste Burning	DOF population forecast, 2020
	Forest Management and Range Improvement	10-year average, held flat
	Others	No growth
Cooking	All	DOF population forecast, 2020
Natural Sources:	Biogenics Vegetation	Held flat in the projection
	Soil NOx	Held flat in the projection. Soil NOx is being presented as a line item in the plan
	Wildfires	10-year average, held flat

Table 5-2 District and CARB Control Rules and Regulations Included in the Inventory for Stationary Sources

Agency	Rule/Reg No.	Rule Title	Source Categories Impacted
SJU_APCD	4103	Open Burning	Agricultural burning
SJU_APCD	4305	Boilers, Process Heaters, and Steam Generators - Phase 2	Fuel combustion / Boilers, Process Heaters, and Steam Generators
SJU_APCD	4306	Boilers, Process Heaters, and Steam Generators - Phase 3	Fuel combustion / Boilers, Process Heaters, and Steam Generators
SJU_APCD	4307	Boilers, Process Heaters, and Steam Generators - 2.0 MMBTU/HR to 5.0 MMBTU/HR	Fuel combustion / Boilers, Process Heaters, and Steam Generators
SJU_APCD	4308	Boilers, Process Heaters, and Steam Generators - 0.075 MMBTU/HR to Less Than 2.0 MMBTU/HR	Fuel combustion / Boilers, Process Heaters, and Steam Generators
SJU_APCD	4309	Dryers, Dehydrators, and Ovens	Industrial processes - dryers, dehydrators and ovens
SJU_APCD	4311	Flares	Oil and gas production- Vapor Recovery
SJU_APCD	4351	Boilers, Process Heaters, and Steam Generators - Phase 1	Fuel combustion / Boilers, Process Heaters, and Steam Generators
SJU_APCD	4352	Solid Fuel Fired Boilers, Steam Generators and Process Heaters	Fuel combustion / Boilers, Process Heaters, and Steam Generators
SJU_APCD	4354	Glass Melting Furnaces	Glass manufacturing
SJU_APCD	4401	Steam-Enhanced Crude Oil Production Wells	Oil and gas production - vapor recovery
SJU_APCD	4402	Crude Oil Production Sumps	Oil and gas production - fugitive losses
SJU_APCD	4408	Glycol Dehydration Systems	Oil and gas production - dehydrators
SJU_APCD	4409	Components at Light Crude Oil Production Facilities, Natural Gas Production Facilities, and Natural Gas Processing Facilities	Oil and gas production - fugitive losses
SJU_APCD	4455	Components at Petroleum Refineries, Gas Liquids Processing Facilities, and Chemical Plants	Petroleum refining - fugitive losses

Agency	Rule/Reg No.	Rule Title	Source Categories Impacted
SJU_APCD	4550	Conservation Management Practices	Tilling and Harvesting, Unpaved Road Dust, and Fugitive Windblown Dust
SJU_APCD	4565	Biosolids, Animal Manure, and Poultry Litter Operations	Composting operations
SJU_APCD	4566	Organic Material Composting Operations	Composting operations
SJU_APCD	4570	Confined Animal Facilities	Livestock operations
SJU_APCD	4601	Architectural Coatings	Architectural coatings and related process solvents
SJU_APCD	4602	Motor Vehicle and Mobile Equipment Coating Operations	Coatings and related process solvents - auto refinishing
SJU_APCD	4603	Surface Coating of Metal Parts and Products, Plastic Parts and Products, and Pleasure Crafts	Coatings and related process solvents - metal parts and products coatings
SJU_APCD	4604	Can and Coil Coating Operations	Coatings and related process solvents - can and coil coatings
SJU_APCD	4605	Aerospace Assembly and Component Coating Operations	Coatings and related process solvents - aerospace assembly and component coatings
SJU_APCD	4606	Wood Coating Operations	Coatings and related process solvents - wood coatings operations
SJU_APCD	4607	Graphic Arts and Paper, Film, Foil and Fabric Coatings	Printing, coatings and related process solvents
SJU_APCD	4610	Glass Coating Operations	Coatings and related process solvents - glass coating operations
SJU_APCD	4612	Automotive Coatings	Coatings and related process solvents - auto refinishing
SJU_APCD	4621	Gasoline Transfer into Stationary Storage Containers, Delivery Vessels, and Bulk Plants	Petroleum marketing - gasoline transfer
SJU_APCD	4622	Gas Transfer into Vehicle Storage Fuel Tanks	Petroleum marketing - vehicle refueling
SJU_APCD	4623	Storage of Organic Liquids	Petroleum refining; petroleum marketing, oil and gas production - organic liquid storage

Agency	Rule/Reg No.	Rule Title	Source Categories Impacted
SJU_APCD	4624	Organic Liquid Loading	Petroleum marketing - organic liquid loading
SJU_APCD	4625	Wastewater Separators	Petroleum refining - waste water treatment
SJU_APCD	4641	Cutback, Slow Cure, and Emulsified Asphalt Paving and Maintenance Operations	Asphalt paving or roofing
SJU_APCD	4642	Solid Waste Disposal Sites	Landfills; waste disposal
SJU_APCD	4651	Volatile Organic Compound Emissions from Decontaminated Soil	Waste disposal / Soil remediation
SJU_APCD	4653	Adhesives and Sealants	Adhesives & sealants
SJU_APCD	4661	Organic Solvents	Coatings and related process solvents; cleaning and surface coatings
SJU_APCD	4662	Organic Solvent Degreasing Operations	Degreasing
SJU_APCD	4663	Organic Solvent Cleaning, Storage and Disposal	Degreasing; cleaning & surface coating
SJU_APCD	4672	Petroleum Solvent Dry Cleaners	Laundering
SJU_APCD	4681	Rubber Tire Manufacturing	Rubber and rubber products manufacturing
SJU_APCD	4682	Polystyrene, Polyethylene, and Polypropylene Products Manufacturing	Plastic and plastic products manufacturing
SJU_APCD	4684	Polyester Resin Operations	Fiberglass and fiberglass products manufacturing
SJU_APCD	4691	Vegetable Oil Processing Operations	Food and agriculture
SJU_APCD	4692	Commercial Charbroiling	Cooking
SJU_APCD	4693	Bakery Ovens	Bakeries
SJU_APCD	4701	Internal Combustion Engines (Phase 1)	Fuel combustion - internal combustion engines
SJU_APCD	4702	Internal Combustion Engines (Phase 2)	Fuel combustion - internal combustion engines
SJU_APCD	4703	Stationary Gas Turbines	Fuel combustion - stationary gas turbines
SJU_APCD	4901	Wood Burning Fireplaces and Wood Burning Heaters	Residential wood combustion
SJU_APCD	4902	Residual Water Heaters	Residential fuel combustion

Agency	Rule/Reg No.	Rule Title	Source Categories Impacted
SJU_APCD	4905	Natural Gas-Fired, Fan-Type Central Furnaces	Service and Commercial / Residential Fuel Combustion - Space Heating
SJU_APCD	REG8	Regulation VIII PM controls	Fugitive Dust
CARB	ARB_R003 & ARB_R003_A	Consumer Product Regulations & Amendments	Consumer products
CARB	ARB_R007	Aerosol Coating Regulations	Aerosol coatings
CARB	GDF_HOSREG	Gasoline Dispensing Facility Hose Emission Regulation	Petroleum marketing - gasoline dispensing facility hoses
CARB	ORVR	Fueling emissions from ORVR vehicles	Petroleum marketing - fueling emissions from ORVR vehicles
CARB	AG_IC_ENG	AG IC Engine Emission Scalars	Agricultural IC Engines
CARB	NONAGICENG	Non-Ag IC Engine Emission Scalars	Non-agricultural IC Engines

5.4.7 External Adjustments

External adjustments were made in CEPAM to account for military growth and other unaccounted regulatory factors. The external adjustments reflected in the CEPAM 2022 PM2.5 Plans v1.00 inventory are listed below in Table 5-3.

Table 5-3 External Adjustment IDs and Descriptions

Adjustment ID	Adjustment Description
HD_I/M	Heavy-Duty Inspection and Maintenance (HD I/M) Regulation adopted by CARB, Dec 2021
ACC_II	Advanced Clean Cars (ACC II) Regulation adopted by CARB, Nov 2022
LEMOORE	External adjustments for NAS Lemoore
NonAg_ICE	Non-ag internal combustion engines adjustment to reflect 2003 ATCM and 2010 rule amendment
SJV_Const	SJV Construction and Mining Equipment -- Recession/Recovery Adjustment (period 2011-2019)

5.5 CONDENSABLE PARTICULATE MATTER

5.5.1 Background

Condensable particulate matter (PM) is material that is vapor phase at stack conditions, but which condenses and/or reacts upon cooling and dilution in the ambient air to form solid or liquid PM immediately after discharge from the stack. Condensable PM is a component of primary PM, which is the sum of condensable and filterable PM. Filterable PM comprises particles that are directly emitted by a source as a solid or liquid [aerosol] at stack or release conditions. All condensable PM is assumed to be smaller than 2.5 microns (μm) in diameter.

The AERR requires states to report annual emissions of filterable and condensable components of PM2.5 and PM10, "as applicable," for large sources every inventory year and for all sources every third inventory year, beginning with 2011.[9] Subsequent emissions inventory guidance[10] from the U.S. EPA clarifies the meaning of the phrase "as applicable" by providing a list of source types for which condensable PM is expected by the AERR. These source types are stationary point and nonpoint combustion sources that are expected to generate condensable PM and include, for instance, commercial cooking, fuel combustion at electric generating utilities, industrial processes like cement or chemical manufacturing, and flares or incinerators associated with waste disposal. The condensable PM from stationary and areawide sources in this inventory is calculated using the methodology outlined below. Condensable PM is not required to be calculated for mobile sources.

5.5.2 Methodology

For the current inventory, the District has collected data on primary PM only, containing both filterable and condensable components without distinguishing between the two. Consequently, to be able to report emissions of the condensable component of PM2.5 separately as required by the AERR, primary PM2.5 is augmented to condensable PM using recommended fractions from U.S. EPA, which are published within their Emissions Inventory System (EIS) Gateway[11]. Because these factors are assigned to Source Classification Codes (SCC), CARB Emission Inventory Codes (EICs) are crosswalked to SCC codes. These factors are then directly applied (multiplied) to primary PM2.5 to calculate condensable PM.

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[9] 40 CFR §51.15(a)(1) and §51.30(b)(1)

[10] U.S. EPA. Emissions Inventory Guidance for Implementation of Ozone and Particulate Matter National Ambient Air Quality Standards (NAAQS) and Regional Haze Regulations. May 2017. https://www.epa.gov/sites/production/files/2017-07/documents/ei_guidance_may_2017_final_rev.pdf

[11] EIS Gateway downloaded on 08/20.2022. https://www.epa.gov/air-emissions-inventories/emissions-inventory-system-eis-gateway

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Appendix A

SUMMARY OF COMMENTS AND RESPONSES

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SUMMARY OF COMMENTS AND RESPONSES
Initial SIP Requirements for the 2012 Annual PM2.5 Standard

COMMENTERS:
Rocky Mountain Institute (RMI)

COMMENT: As the Air District builds out its pollution control strategies for the *2023 PM2.5 Plan*, the agency should pursue both near-term and long-term emission reductions through regional zero-NOx appliance standards for space and water heating. (RMI)

RESPONSE: CARB began the public process for the development of zero-emission appliance standards in May 2023. CARB has committed to conduct an extensive investigation into this measure, develop a proposed rule through meaningful public engagement, and bring the proposed rule before their Board by 2025. The District continues to support CARB in the development and implementation of this measure, as it will result in emission reductions and associated health benefits in the San Joaquin Valley. Additionally, the District and CARB are continuing to evaluate potential control measures to develop the attainment strategy for the upcoming Plan, including the potential to achieve earlier emissions reductions from building appliances through regulatory and incentive-based approaches, taking into consideration technologic and economic feasibility for Valley residents.

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Attachment A

LOCAL TRANSPORTATION CONTROL MEASURE REVIEW & BEST AVAILABLE CONTROL TECHNOLOGY ANALYSIS

MEMORANDUM

To: San Joaquin Valley Metropolitan Planning Organization (MPO) Staff

From: Suriya Vallamsundar and Alex Marcucci, Trinity Consultants

Date: April 12, 2023

RE: Local Transportation Control Measure Review and Best Available Control Measure (BACM) Analysis for the San Joaquin Valley 2023 Particulate Matter ($PM_{2.5}$) State Implementation Plan

This memorandum presents the results and methodology for conducting local Best Available Control Measure (BACM) analysis in support of the 2023 San Joaquin Valley (SJV) Particulate Matter ($PM_{2.5}$) State Implementation Plan (SIP) for the annual 2012 $PM_{2.5}$ standard. In July 2022 as part of the SJV 2022 Ozone Plan development, Trinity Consultants (Trinity) conducted a comprehensive Reasonable Available Control Measure (RACM) analysis for the eight SJV Metropolitan Planning Organizations (MPOs) with the purpose of identifying additional transportation control measures (TCMs) in line with the requirements of the U.S. Environmental Protection Agency's (EPA's) Ozone Implementation Rule[1]. As part of the 2022 Ozone SIP RACM analysis, new TCMs were identified and are currently being implemented by the Valley MPOs.[2]

The SJV is designated as Serious nonattainment for the 2012 $PM_{2.5}$ standard and as a result, the nonattainment area is required to conduct a Best Available Control Measure (BACM) analysis including TCM review for the control of direct $PM_{2.5}$ and $PM_{2.5}$ precursors from on-road mobile sources for the 2023 $PM_{2.5}$ Plan. The Final $PM_{2.5}$ Rule[3] differentiates between the RACM and BACM as follows, "… the EPA proposed to interpret the control requirements addressed by CAA section 189(e) to include RACM/RACT (and additional reasonable measures) for Moderate nonattainment areas, BACM/BACT (and additional feasible measures) for Serious nonattainment areas, most stringent measures (MSM) (for Serious areas as applicable) and NNSR on all major sources of precursors in the nonattainment areas." According to the steps laid out in the Final $PM_{2.5}$ Rule, the TCM BACM analysis consists of reviewing existing TCMs in the SJV, as well as measures implemented in other Moderate and Serious $PM_{2.5}$ nonattainment areas throughout the country, and evaluating the technological and economic feasibility of any new measures identified. This analysis demonstrates that TCM projects that are already being implemented in the Valley meet BACM requirements. No additional measures were identified for implementation.

Background

According the Final Rule, the BACM selection process for implementation of the $PM_{2.5}$ NAAQS consists of the following steps[3]:

[1] EPA, 2018. Implementation of the 2015 National Ambient Air Quality Standards for Ozone: State Implementation Plan Requirements. Final Rule. U.S. Environmental Protection Agency. Vol. 83. No. 234. December 6, 2018.

[2] San Joaquin Valley Air Pollution Control District. 2022 Ozone Plan for the San Joaquin Valley. Appendix D Mobile Source Control Strategy. Accessed at https://ww2.valleyair.org/media/rtrjnlxo/13-appendix-d-mobile-source-control-strategy.pdf.

[3] Federal Register, Vol. 81, No 164, Accessed at https://thefederalregister.org/81-FR/Issue-164/FR-2016-08-24.pdf, Pg. 58084.

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- Step 1: Develop a comprehensive inventory of sources and source categories of directly emitted $PM_{2.5}$ and $PM_{2.5}$ precursors.
- Step 2: Identify existing and potential control measures for the sources in the inventory.
- Step 3: Evaluate the technological feasibility of potential control measures.
- Step 4: Evaluate the economic feasibility of potential control measures.
- Step 5: Determine the earliest date by which a control measure or technology can be implemented in whole or in part.

In July 2022, Trinity Consultants (Trinity) conducted a comprehensive RACM analysis for the eight SJV Metropolitan Planning Organizations (MPOs) which identified new TCMs focused on complete streets and educational campaign projects that promote non-vehicular travel modes and eco-driving techniques. In addition, the SJV MPOs, the Air District, and CARB are already implementing TCMs that aim to reduce VMT and emissions from mobile sources in response to SB 375 and other federal, state, and local goals and requirements. Appendix D of the SJV 2022 Ozone Plan[2] provides additional details on the RACM methodology and final TCM listing for each SJV MPO, as well as an overview of existing state and Air District control measures. In addition to the TCMs identified through the RACM process, Trinity followed the process outlined below to evaluate whether there are any additional TCMs that would be considered BACM.

BACM Analysis Methodology

Step 1: Identify measures currently implemented in the SJV

The first step consisted of developing a comprehensive listing of TCMs that are already being implemented in the eight SJV counties – Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare. Appendix D of the 2022 SJV Ozone Plan provides details on the data sources utilized and current measures implemented by the SJV MPOs.

Step 2: Develop a list of TCMs implemented in other nonattainment areas

Once existing TCMs were identified, the second step was to compile a list of all candidate TCMs that were implemented in other $PM_{2.5}$ nonattainment areas. For this analysis, the BACM review included relevant SIPs from $PM_{2.5}$ nonattainment areas for 1997, 2006, and 2012 $PM_{2.5}$ standards. Since many of the SIPs reviewed as part of SJV 2022 Ozone SIP RACM analysis consist of integrated air quality plans targeting both ozone and $PM_{2.5}$, this step was already covered in detail as part of 2022 Ozone Plan development. However, additional TCMs were identified from $PM_{2.5}$ nonattainment areas where the TCMs were developed specifically for particulate matter. Table 1 shows the nonattainment areas, their designation, and the applicable SIPs reviewed in support of this BACM analysis. A total of 43 unique TCMs were identified and condensed into 23 TCM categories by utilizing only the measures that are significantly different in scope and emissions reduction potential. The TCM listing was kept consistent with previous TCM lists developed as part of ozone RACM analysis. Appendix A shows the 23 TCMs identified as part of the review of $PM_{2.5}$ SIPs and includes both new and existing TCMs.

The programs and regulations implemented in the SJV as a result of statewide or district-wide measures were also reviewed as part of the RACM analysis which will apply to the BACM process. The majority of these measures correspond to controlling the extended idling of vehicles, encouraging vehicle turnover, and employer-based trip reduction measures, etc.

Table 1. $PM_{2.5}$ Nonattainment Areas Reviewed for Candidate TCMs

Region	Designation	Applicable SIP
South Coast Air Quality Management District	Serious for 2012 and 2006 PM2.5 Standards and Moderate for 1997 PM2.5 Standards	2020 Air Quality Management Plan, South Coast Air Quality Management District (incl. 2016 RACM/BACM analysis)[1]
Alaska Department of Environmental Conservation (Fairbanks)	Serious for 2006 PM2.5 Standards	2020 Amendments to the Serious SIP
Northern Sierra Air Quality Management District (Plumas County)	Serious for 2012 PM2.5 Standards	2017 Portola Fine Particulate Matter (PM2.5) Attainment Plan
Allegheny County Health Department Air Quality Program (Allegheny)	Moderate for 2012 PM2.5 Standards	2019 Attainment Demonstration for the Allegheny County, PA PM2.5 Nonattainment Area, 2012 NAAQS
Imperial County Air Pollution Control District	Moderate for 2012 and 2006 PM2.5 Standards	2018 Imperial County Annual Particulate Matter less than 2.5 microns in diameter State Implementation Plan
Utah Air Quality Board (Salt Lake City)	Serious for 2006 PM2.5 Standards	2019 Control Measures for Area and Point Sources, Fine Particulate Matter, Serious Area PM2.5 SIP for the Salt Lake City, UT Nonattainment Area 2020 Technical Support Documentation for Utah's Salt Lake City and Provo 2006 24-Hour PM2.5 State Implementation Plans
Utah Air Quality Board (Provo)	Serious for 2006 PM2.5 Standards	2018 Provisions to Ensure BACM/BACT for the Provo, UT Serious PM2.5 Nonattainment Area 2020 Technical Support Documentation for Utah's Salt Lake City and Provo 2006 24-Hour PM2.5 State Implementation Plans
Oregon Department of Environmental Quality (Klamath Falls)	Moderate for 2006 PM2.5 Standards	2012 Klamath Falls Fine Particulate Matter (PM2.5) Attainment Plan
Allegheny County Health Department Air Quality Program (Liberty-Clairton)	Moderate for 2006 and 1997 PM2.5 Standards	2011 Attainment Demonstration for the Liberty-Clairton PM2.5 Nonattainment Area
Sacramento Metropolitan Air Quality Management District (Sacramento)	Moderate for 2006 PM2.5 Standards	2013 PM2.5 Implementation/Maintenance Plan and Re-designation Request for Sacramento PM2.5 Nonattainment Area
Bay Area Air Quality Management District (San Francisco Bay Area)	Moderate for 2006 PM2.5 Standards	Spare the Air: 2017 Clean Air Plan
Montana Department of Environmental Quality (Libby)	Moderate for 1997 PM2.5 Standards	2020 Request for Redesignation of the Libby PM2.5 Nonattainment Area and Approval of an Attainment Area Limited Maintenance Plan

[1] The South Coast Air Quality Management District 2020 Air Quality Management Plan is an integrated plan for both Ozone and $PM_{2.5}$ and was evaluated in detail as part of the RACM analysis for 2022 Serious Ozone Plan

Step 3: Evaluate Implementation Feasibility of Measures

Once the list of additional potential TCMs was compiled, the next step was to collect sufficient information on each candidate measure to determine its feasibility for each SJV MPO based on the applicability, implementational authority, and technological and economic feasibility.

Step 4: Identify the Best Available Control Measures

The final step consists of finalizing the TCMs for each SJV MPO. Table 2 shows additional TCMs identified with this BACM analysis, along with their evaluation and justification for their disqualification based on the assessment of the metrics discussed in the previous step.

Table 2. SJV New BACM TCMs Identified from $PM_{2.5}$ SIP Review

TCM #	TCM	Description	Analysis	Comments
	i. Improved Public Transit			
1.14	Outreach Programs	Public education focused on using the transit programs	Newly Proposed RACM TCM in the 2022 Ozone Plan	
	v. Reduce Extreme Cold-Start Emissions			
5.1	Use of plug-ins	Expanded availability of plug-ins to facilitate cold weather starting of vehicles and reduce engine idling time	Not Applicable	
5.2	Electrification of parking lot outlets	Electrification of parking lot outlets at temps < 21° F	Not Applicable	
5.3	Outreach Programs	Public education focused on the benefits of plugging-in	Not Applicable	
	ix. Pre-1980 Model-Year Vehicle Scrappage			
9.3	Retrofit Programs	On-road diesel engine retrofits for school buses, trucks, and transit buses	Existing	SJVAPCD Incentive Programs; CARB ATCM and Truck and Bus Rule
	x. Transit-Only or High Occupancy Vehicle Lanes			
10.3	Express Lanes	Price travel demand on highways by developing an express lane network for vehicles	No implementation authority	Would require state agency authority and funds
	xv. Limit or Restrict Vehicle Use in Downtown Areas			
15.11	Pricing Policies	Transportation Pricing (such as tolling and cordon pricing) to reduce the vehicle miles traveled	No implementation authority	Pricing policies are set by each jurisdiction and/or the State
	xvi. High-Occupancy and Ridesharing Programs			
16.7	Outreach programs	Public Education and Outreach Program	Newly Proposed RACM TCM in the 2022 Ozone Plan	

BACM Analysis Results

Based on the BACM review, no additional TCMs were selected for implementation because of the following reasons:

- Based on the latest RACM analysis for the SJV 2022 Ozone Plan, all CAA Section 108(f)(1)(A) TCM categories are already being implemented in the SJV. This is the result of the most stringent air quality and conformity requirements due to SJV's extreme non-attainment status for both 2008 and 2015 ozone standards.
- The new TCMs identified through the BACM process are either already implemented in the SJV or cannot be implemented due lack of implementation authority or not being applicable to the SJV region (e.g., plug-ins in extreme cold climatic conditions in Fairbanks, AK).
- The TCMs which did not constitute RACM in 2022 Ozone Plan would not constitute BACM. The justifications given for disqualifications are as follows:
    - No Authority: if SVJ MPOs have no authority to implement a RACM TCM, the same applies to BACM.
    - Not Economically Feasible: TCMs that are cost-ineffective as RACM are also not economically feasible for BACM.
    - Not applicable: some TCMs are not feasible either because of State laws or because the TCMs are unique to the region where they are being implemented.
    - Would not advance attainment: some of the RACM TCMs were rejected based on the fact that these measures cannot advance attainment.[4] While advancing attainment is one of the criteria for RACM analysis, it is not listed as one of the steps in a BACM process. These measures were evaluated in detail as part of the BACM process. While the key reason for rejecting these measures as a RACM TCM was not being able to advance attainment, these measures were also determined as not economically feasible or SJV MPOs do not have implementation authority to enforce some of the measures. A combination of economic infeasibility and lack of authority dismisses these TCMs as a BACM.
- The SJV MPOs comply with California's SB 375 and have adopted Sustainable Community Strategies (SCSs) that address per capita GHG emission reductions through sustainable transportation and land-use planning. While the focus of SB 375 is on GHG emissions, there are some co-benefits on the air quality side as well due to reductions in VMT and other policies such as partnering with the state and the Air District on electric vehicle deployment.

The BACM analysis demonstrates that the TCM projects being implemented in the SJV meet BACM requirements; no new measures were identified.

[4] *Measures include 2.1 Establish auto-free zones and pedestrian malls, 3.2 Providing free bikes to transit users, 15.4 Reversible lanes to change the direction of travel during special events or congested periods, and 17.4 Providing clean fleet vehicles for government employees.*

Appendix A

Table A1. SJV Transportation Control Measure BACM Analysis

TCM #	TCM	Description	Analysis	Comments
	i. Improved Public Transit			
1.2	Expansion of public transportation services	Expanded transit service includes improved service frequency on high ridership routes, new routes and better bus stop facilities	Existing	RTP/SCS
1.5	Transit rehabilitation and retrofits	Onroad diesel engine retrofits for transit buses	Existing	AFVs are required per CARB Zero Emission Transit Rule
1.6	Transit service improvement including parking management	Improve transit efficiency	Existing	RTP/SCS
1.9	Land use strategies to prioritize transit	Land use strategies to facilitate walking, bicycling and transit use	Existing	RTP/SCS
1.13	Passenger Rail Improvements	Improve Local and Regional Rail Service	Existing where applicable	RTP/SCS
1.14	Outreach Programs	Public education focused on using the transit programs	Newly Proposed RACM TCM in the 2022 Ozone Plan	
	iv. Control Extended Idling of Vehicles			
4.2	Programs to reduce idling of vehicles	Reduce idling at drive-throughs, parking lots, in traffic, at schools, and other locations, etc. Use of APUs or special battery engines to keep air conditioning and other vehicle systems when the vehicle is not in use.	Existing/Statewide	CARB ATCM
	v. Reduce Extreme Cold-Start Emissions			
5.1	Use of plug-ins	Expanded availability of plug-ins to facilitate cold weather starting of vehicles and reduce engine idling time	Not Applicable	
5.2	Electrification of parking lot outlets	Electrification of parking lot outlets at temps < 21° F	Not Applicable	
5.3	Outreach Programs	Public education focused on the benefits of plugging-in	Not Applicable	

	viii. Construction/Reconstruction of Paths for Non-Motorized Use			
8.1	Bicycle/pedestrian facilities	Bicycle and Pedestrian Access and Facilities Improvements	Existing	RTP/SCS
8.4	Safe Routes to School Programs	Safe Routes to Schools and Safe Routes to Transit Programs	Existing	RTP/SCS
	ix. Pre-1980 Model-Year Vehicle Scrappage			
9.3	Retrofit Programs	On-road diesel engine retrofits for school buses, trucks, and transit buses	Existing	SJVAPCD Incentive Programs and CARB ATCM and Truck and Bus Rule
	x. Transit-Only or High Occupancy Vehicle Lanes			
10.3	Express Lanes	Price travel demand on highways by developing an express lane network for vehicles	No implementation authority	Would require state agency authority and funds
	xi. Employer-Based Plans and Incentives			
11.8	Employer Rideshare Program Incentives	Employer-based rideshare incentives and introduction of strategies designed to reduce single-occupant vehicle trips. Examples include public awareness campaigns, Transportation Management Associations among employers, alternative work hours, and financial incentives for TCM participants as well as tax breaks for employers. Provide outreach and possible financial incentives to encourage local employers to provide transit passes or subsidies to encourage less individual vehicle travel.	Existing	SJVAPCD Employer Based Trip Reduction/Rule 9410
	xiii. Traffic Flow Improvements			
13.3	Intersection Improvements	Installation of turn lanes, curbs, traffic signals, realign skewed intersections to provide better traffic flow and safety.	Existing	FTIP/RTP
13.4	Eco-driving educational program	Public education and outreach to encourage drivers to observe posted speed limits and adopt other fuel-efficient driving practices	Newly Proposed RACM TCM in the 2022 Ozone Plan	
13.8	Traffic Signal Synchronization/Traffic Signal Improvements	Install synchronized traffic signals, adaptive traffic signals, median dividers, turn lanes, and grade separations	Existing	FTIP/RTP
13.14	Pavement Resurfacing and Rehabilitation	Road Paving to reduce re-suspended road dust	Existing	FTIP/RTP
	xv. Limit or Restrict Vehicle Use in Downtown Areas			
15.2	Parking Fee Regulations	Parking fees can be increased in different forms such as the highest charges for parking in central business districts, increase fees for parking garages to deter vehicle use during high ozone level days, and charging city-owned parking garage pass holders a fee for more than one entrance and exit each day, etc.	No implementation authority	Parking fees are set by each jurisdiction

15.11	Pricing Policies	Transportation Pricing (such as tolling and cordon pricing) to reduce the vehicle miles traveled	No implementation authority	Pricing policies are set by each jurisdiction and/or the State
	xvi. High-Occupancy and Ridesharing Programs			
16.3	Vanpool program	Commuter Van Pool program	Existing	RTP/SCS
16.7	Outreach programs	Public Education and Outreach Program	Newly Proposed RACM TCM in the 2022 Ozone Plan	