Appendix C

Stationary Source Control Measure Analyses

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C. STATIONARY SOURCE CONTROL MEASURE ANALYSES

The San Joaquin Valley (Valley) faces significant challenges in attaining national ambient air quality standards (NAAQS, or standards) for PM2.5 and ozone. Despite the progress made to improve the Valley's air quality through the implementation of the multiple attainment plans adopted by the San Joaquin Valley Air Pollution Control District (District) and clean air investments by Valley businesses and residents, the Valley continues to face significant challenges attaining federal PM2.5 standards. Substantial additional emissions reductions are needed, particularly from mobile sources under California Air Resources Board (CARB) and U.S. Environmental Protection Agency (EPA) jurisdiction that make up over 85% of remaining Valley NOx emissions. The Valley has already attained the PM10 standard and the 1997 24-hour 65 µg/m³ standard. Tough and innovative rules, such as those for indirect source review, residential wood burning, and agricultural burning, have set benchmarks for California and the nation.

The District has adopted many regulatory control measures under the District's air quality attainment plans, including but not limited to the *2007 Ozone Plan, 2008 PM2.5 Plan, 2012 PM2.5 Plan, 2013 Plan for the Revoked 1-Hour Ozone Standard, 2015 Plan for the 1997 PM2.5 Standard, 2016 Plan for the 2008 8-Hour Ozone Standard,* and the *2016 Moderate Area Plan for the 2012 PM2.5 Standard*. Chapter 4 of this Plan includes a discussion about District regulations that have already been adopted and that achieve new emissions reductions after 2013 contributing to attainment. Appendix D contains mobile sources analyses and discussions.

While the District has adopted numerous rules to reduce emissions from stationary and area sources that will achieve significant emissions reductions in the coming years, for this Plan the District has evaluated all potential additional opportunities for reducing emissions to achieve expeditious attainment of the federal PM2.5 NAAQS. This appendix reflects the comprehensive evaluation performed by the District to examine emissions sources in the Valley to identify additional potential emission reduction strategies for inclusion in this Plan.

Given the significant emissions reductions already achieved through stationary and area source regulatory strategies and the significant investment necessary to achieve emissions reductions, the Valley is at the point of diminishing returns from new regulatory controls on stationary and area sources. The search for emission reduction opportunities goes beyond traditional regulatory strategies and considers other opportunities for timely, innovative, and cost effective emissions reductions, including new incentive programs.

This appendix 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 appendix 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 Clean Air Act control strategy requirements for PM2.5 nonattainment areas.

Clean Air Act Requirements

With respect to control strategy requirements, the Federal Clean Air Act (CAA) requires demonstration of Reasonably Available Control Measures for Moderate non-attainment areas under Section 189(a)(1)(C); Best Available Control Measures for Serious non-attainment areas under Section 189(b)(1)(B); and Most Stringent Measures for Serious non-attainment areas seeking an extension under section 188(e). The guidelines for demonstrating compliance with these requirements are provided in EPA's 2016 *Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule*, codified at 81 FR 58009. The control strategy requirements are based on the non-attainment status of the area.

For each federal PM2.5 standard, the San Joaquin Valley's nonattainment status is as follows:

- *2012 PM2.5 Standard*
  - Moderate nonattainment area that cannot practicably attain the standard by the applicable attainment deadline
  - If reclassified, Serious nonattainment area that can attain the standard by the applicable attainment deadline
- *2006 PM2.5 Standard*
  - Serious nonattainment area seeking an attainment deadline extension
- *1997 PM2.5 Standard*
  - Serious nonattainment area that failed to attain the standard by the applicable attainment deadline

Moderate Area Control Strategy Requirements

Pursuant to CFR Section 51.1009, the state shall identify, adopt, and implement control measures on sources of direct PM2.5 and significant PM2.5 precursors (NOx) located in any Moderate PM2.5 nonattainment area or portion thereof located within the state consistent with the following:

- The state shall identify potential control measures to reduce emissions from sources of direct PM2.5 and PM2.5 precursors (NOx)
- For any potential control measure, the area may make a demonstration that such measure is not technologically or economically feasible to implement in the area by the end of the sixth calendar year following the effective date of designation, and may eliminate such measure from further consideration.
  - **Technological feasibility** may include, but is 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.

    - **Economic feasibility** may include but is not limited to capital costs, operating and maintenance costs, and cost effectiveness.
    - A detailed written justification for eliminating a potential control measure on the basis of technological or economic infeasibility shall be included with the control measure evaluation.
- **If the state demonstrates through air quality modeling that the area can attain** the applicable PM2.5 NAAQS by the end of the sixth calendar year following the effective date of designation of the area, the state shall adopt and implement all technologically and economically feasible control measures that are necessary to bring the area into attainment by such date.
    - The state shall also adopt and implement all other technologically and economically feasible measures that, when considered collectively, would advance the attainment date for the area by at least 1 year.
    - Any control measure that can be implemented by 4 years after the effective date of designation of the Moderate PM2.5 nonattainment area shall be considered RACM for the area. Any such control measure that is also a control technology shall be considered RACT for the area.
    - Any control measure that can only be implemented during the period beginning 4 years after the effective date of designation of the Moderate PM2.5 nonattainment area through the end of the sixth calendar year following the effective date of designation of the area shall be considered an *additional reasonable measure* for the area.
- **If the state demonstrates that the area cannot practicably attain** the applicable PM2.5 NAAQS by the end of the sixth calendar year following the effective date of designation of the area, the state must adopt all technologically and economically feasible control measures that can be implemented in whole or in part by the end of the sixth calendar year following the effective date of designation of the area.

The Valley is currently designated as Moderate non-attainment for the 2012 PM2.5 Standard and cannot practicably attain the 2012 PM2.5 Standard by the end of the sixth calendar year following the effective date of designation of the area. As such, as explained above, the state must adopt all technologically and economically feasible control measures that can be implemented in whole or in part by the end of the sixth calendar year (attainment deadline of 2021) following the effective date of designation of the area. The District adopted the *2016 Moderate Area Plan for the 2012 PM2.5 Standard*, including an attainment impracticability demonstration and a request for reclassification of the Valley from Moderate nonattainment to Serious nonattainment. This plan was submitted to CARB for review and consideration in September of 2016.

The control measure evaluations in this Appendix go beyond the level of analysis required to satisfy Clean Air Act Moderate Area attainment Plan requirements, including RACM and RACT, as follows:

✓ All emission source categories that emit direct PM2.5 or a significant PM2.5 precursor (NOx) have been evaluated.

- ✓ For each source category, source, or activity, an inventory of direct PM2.5 and PM2.5 precursors has been provided.
- ✓ Measures in other NAAQS nonattainment areas are identified and evaluated in each control measure analysis.
- ✓ Any other control measures or technologies achieved in practice in other areas are evaluated for technological and economic feasibility of implementation in the Valley.
- ✓ A detailed justification for the rejection of any measures based on technological or economic infeasibility has been provided.
- ✓ The control measure analysis evaluates technological and economic feasibility beyond those that can only be implemented within 4 years or 6 years.

SERIOUS AREA CONTROL STRATEGY REQUIREMENTS

The District is classified as Serious nonattainment for multiple PM2.5 standards. For each PM2.5 NAAQS, the Valley has a different attainment status, which results in different requirements for each standard. For the 2012 PM2.5 standard, the District is requesting that the Valley be reclassified from Moderate to Serious nonattainment, with a Serious area attainment date of 2025. For the 2006 PM2.5 standard, the Valley is classified as Serious nonattainment, and the District is requesting an attainment date extension to 2024.

As a result of the District's attainment status for the three different federal PM2.5 standards, the District must demonstrate an increasing stringency of analysis for evaluating the feasibility of control measures to reduce direct PM2.5 and PM2.5 precursors. The different requirements for each standard are outlined below.

CONTROL STRATEGY REQUIREMENTS FOR THE 1997 PM2.5 STANDARD

For the 1997 PM2.5 standard, the District is classified as Serious nonattainment. Per Section 189(d) of the CAA, the District is required to submit a Plan demonstrating that the annual emissions inventory for PM2.5 and significant PM2.5 precursors is reduced by at least 5% annually until the Valley reaches attainment. The District's 5% demonstration, contained in Chapter 5, relies on emission reductions occurring as a result of current control measures. The adoption and implementation of additional feasible measures identified in this Appendix will ensure that the emission inventory for direct PM2.5 and PM2.5 precursors will continue to be reduced and will ensure attainment of the 1997 PM2.5 standard no later than 2020.

CONTROL STRATEGY REQUIREMENTS FOR THE 2006 PM2.5 STANDARD

For the 2006 PM2.5 standard, the District is classified as Serious nonattainment and is requesting an attainment deadline date extension from 2019 to 2024 due to the impracticability of attaining the 24-hour 35 μ/m^3 standard by 2019. This Plan demonstrates that the District will attain the 2006 PM2.5 NAAQS by 2024.

Section 51.1010 (b) states that, for a Serious PM2.5 nonattainment area that cannot practicably attain the applicable PM2.5 NAAQS by the end of the tenth calendar year following the date of designation of the area, 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 that can be feasibly implemented in the area, consistent with the following requirements:

1. The state shall identify all sources of direct PM2.5 emissions and all sources of PM2.5 precursors
2. The state shall identify potential control measures to reduce emissions from the identified sources as follows:
   a) The state shall identify the most stringent measures adopted into any SIP or used in practice to control emissions in any state.
   b) 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 control strategy for the area.
3. The state may make a demonstration that a measure identified is not technologically or economically feasible to implement in the area by 5 years after the applicable attainment date for the area, and may eliminate such whole or partial measure from further consideration.
   - A detailed written justification must be provided for eliminating any potential measure on the basis of technological or economic infeasibility.
4. The state shall adopt and implement all control measures identified as economically and technologically feasible that shall collectively achieve attainment as expeditiously as possible, and not later than five years after the applicable attainment date for the area.

Because BACM and BACT represent the ''best'' level of control feasible for an area, in some cases it may be possible for the MSM requirement to result in no more controls and no more emissions reductions in an area than result from the implementation of BACM and BACT. Stated another way, there may be sources or categories for which no other feasible controls exist beyond what a state has already adopted as BACM or BACT.

This Plan satisfies the requirements for a Serious nonattainment area seeking an attainment date extension as follows:

✓ The updated emissions inventory is included in this Plan.

✓ The control measure evaluations analyze all potential control measures achieved in practice or identified as potential MSM in other regions, as obtained from:
  - A comprehensive review of other air district Plans and regulations
  - A review of the RACT/BACT/LAER Clearinghouse
  - A review of measures included in EPA's Menu of Control Measures document[1]

✓ Measures rejected as BACM/BACT in previous District attainment Plans were reanalyzed to see if they were feasible for implementation given the longer time to the attainment date.

[1] The Menu of Control Measures document is available at: http://www3.epa.gov/ttn/naaqs/pdfs/MenuofControlMeasures.pdf

- ✓ Measures already implemented in the Valley were evaluated to see if an increase in coverage of the measure would increase emission reductions from the source category.
- ✓ A reasoned justification is provided for any potential MSM which was found to be technologically or economically infeasible for implementation in the Valley.

Measures identified as MSM which were found to be technologically and economically feasible for implementation in the Valley will be outlined in Chapter 4, Attainment Strategy; with the date for implementation of MSM being as soon as feasibly possible, and no later than 1-year prior to the requested extended attainment date of 2024.

CONTROL STRATEGY REQUIREMENTS FOR THE 2012 PM2.5 STANDARD

For the 2012 PM2.5 standard, the District is classified as Moderate nonattainment, and is requesting to be reclassified to Serious nonattainment due to the demonstrated impracticability of attaining the 2012 annual standard of 12 μ/m^3 by the Moderate attainment deadline date of 2021. A reclassification to Serious nonattainment for the 2012 NAAQS would change the Valley's attainment date for the 2012 PM2.5 standard to 2025.

This Plan demonstrates that the Valley can attain the 12 μ/m^3 annual standard by 2025 through the implementation of all feasible potential control measures by the applicable attainment date. As a part of the Serious area attainment demonstration for this standard, in addition to implementing all feasible measures identified as RACM and RACT through the Moderate Area analysis, the District is required to identify, adopt, and implement the best available control measures (BACM) on sources of direct PM2.5 and PM2.5 precursors consistent with the following:[2]

- 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 in the nonattainment area by surveying other NAAQS nonattainment areas and identifying any measures for direct PM2.5 and PM2.5 Plan precursors not previously identified by the District during the development of the Moderate area attainment Plan
- Adopt and implement all feasible potential control measures.
    - Any control measure that can be implemented by the end of the fourth year following the date of reclassification of the area to Serious shall be considered BACM. Any such control measure that is also a control technology for a stationary source in the area shall be considered BACT for the area.
    - Any control measure that can be implemented between the end of the fourth year following the date of reclassification of the area to Serious and the applicable attainment date for the area shall be considered an *additional feasible measure*.

[2] § 51.1010 Serious area attainment Plan control strategy requirements

- The District may make a demonstration that any measure is not technologically or economically feasible to implement in whole or in part by the end of the tenth calendar year following the effective date of designation of the area, and may eliminate such whole or partial measure from further consideration.
    - For purposes of evaluating the technological feasibility of a potential control measure, the District may consider 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.
    - For purposes of evaluating the economic feasibility of a potential control measure, the District may consider capital costs, operating and maintenance costs, and cost effectiveness of the measure.
    - The District shall submit to the EPA as part of its Serious area attainment Plan submission a detailed written justification for eliminating from further consideration any potential control on the basis of technological or economic infeasibility.
    - For potential measures the District demonstrates are not technologically or economically feasible to implement, the written justification shall include an explanation of how the criteria for determining the technological and economic feasibility of potential control measures are more stringent than its criteria for determining the technological and economic feasibility of potential control measures for RACM for the same sources.

The control measure evaluations in this Appendix go beyond the level of analysis required to satisfy Clean Air Act Serious Area attainment Plan requirements, including BACM and BACT, as follows:

- ✓ All emission source categories that emit direct PM2.5 or a significant PM2.5 precursor (NOx) have been evaluated.
- ✓ For each source category, source, or activity, an inventory of direct PM2.5 and PM2.5 precursors has been provided.
- ✓ Measures in other NAAQS nonattainment areas are identified and evaluated in the "Potential Regulatory Emission Reductions" section of each control measure analysis.
- ✓ A comprehensive list of control measures considered for each source category is included as a part of each control measure evaluation.
- ✓ Building on the level of analysis required for a Moderate nonattainment Plan, the control measure evaluations go beyond RACM by evaluating all potential control measures achieved in practice that can feasibly be implemented by the attainment date of 2025
    - Control measure commitments and dates are identified in Chapter 4. Measures implemented within 4 years of a Serious PM2.5 designation are considered *BACM*, and associated control technologies are considered *BACT*.
    - Measures implemented after 4 years for a Serious area are considered *additional reasonable measures.*

- ✓ For measures determined not feasible, a thorough explanation of criteria used to make such determinations is provided.
- ✓ For each technologically feasible measure, the following information is provided in regards to economic feasibility:
    - The control efficiency by pollutant
    - The possible emission reductions by pollutant
    - The estimated cost per ton of pollutant reduced; and
    - A determination of whether the measure is economically feasible, including an explanation of the conclusion and quantitative supporting documentation
- ✓ For each technologically and economically feasible control measure, a date for implementation of the rule or policy is included; the date for implementation of control measures relied on for the attainment demonstration shall be as early as feasibly possible, and not later than the beginning of the attainment year.

SIGNIFICANT PRECURSORS

Pursuant to federal Clean Air Act §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 also 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.

Regions are required to address all PM2.5 precursors unless EPA determines the precursor is not a significant contributor to exceedances of a standard for the region. CARB modeling performed for the development of this attainment Plan demonstrates that VOC, Ammonia, and SOx are not significant precursors for the formation of PM2.5 in the San Joaquin Valley. As such, the District is not required to evaluate its VOC, SOx, and ammonia regulations.

In an effort to continue to protect public health beyond the requirements of the NAAQS, the District has implemented the most stringent controls feasible for local sources of SOx and ammonia. Even though the District is not required to evaluate ammonia as part of this Plan, this Appendix includes a full analysis of the potential control of ammonia sources, including an evaluation of BACM and MSM feasible for implementation in the Valley.

APPENDIX C ORGANIZATION AND EVALUATION

Each control measure evaluation includes a discussion of the rule applicability and rule adoption/amendment history; an overview of the source category and affected sources; an emissions inventory table for the source category; a regulatory evaluation; a technological feasibility and cost effectiveness analysis of any other potential best available control measures (BACM) and most stringent measures (MSM); and a summary of the evaluation findings. The sections below elaborate in more detail with respect to the information included within each individual rule evaluation.

Discussion

This section provides an overview of rule applicability, identifies what types of emissions the rule controls, provides the rule adoption/amendment history, and discusses additional pertinent details, as necessary.

Emissions Inventory

Each emissions inventory table lists the annual average and wintertime average (November through April) PM2.5 and NOx emissions for the respective source category. The data provided in this section is a compilation of the data sources identified in the emission inventory appendix. See Appendix B (Emission Inventory) for additional information.

Source Category

This section discusses what types of units, industries, or operations are included in the respective source category.

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, and the regulations and standards in other air districts. 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)[3]
- Alternative Control Techniques (ACT)[4]
- New Source Performance Standards (NSPS)[5]
- National Emission Standards for Hazardous Air Pollutants (NESHAP)[6]

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[3] EPA. Control Techniques Guidelines. Retrieved from http://www.epa.gov/groundlevelozone/SIPToolkit/ctgs.html
[4] EPA. Alternative Control Techniques. Retrieved from http://www.epa.gov/groundlevelozone/SIPToolkit/ctgs.html
[5] 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
[6] EPA. 40 CFR 61 – National Emission Standards for Hazardous Air Pollutants (NESHAPs). Retrieved from http://www.tceq.state.tx.us/permitting/air/rules/federal/61/61hmpg.html

- Maximum Achievable Control Technology (MACT)[7]

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)[8] 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?

As agreed to by EPA for the *2009 RACT SIP*, the rules were also compared to analogous regulations adopted by California's most progressive air districts. Control strategies and measures in other air districts and agencies include, but are not limited to the following air districts:

- South Coast Air Quality Management District (SCAQMD)[9]
- Bay Area Air Quality Management District (BAAQMD)[10]
- Sacramento Metropolitan Air Quality Management District (SMAQMD)[11]
- Ventura County Air Pollution Control District (VCAPCD)[12]

All potential BACM/MSM identified through this regulatory evaluation were then thoroughly evaluated using the following key factors, as defined in EPA's 2016 *Fine Particulate Matter National Ambient Air Quality Standards: State Implementation Plan Requirements; Final Rule*, codified at 81 FR 58009, to determine if potential opportunities qualify as BACM/MSM for the Valley:

- **Technological feasibility**– This analysis determines if the new control can be integrated with the existing controls without reducing or delaying the emission reductions from the existing control. If it cannot, then it would not be considered to be technologically feasible for the area unless the emission benefit of the new measure is substantially greater than the existing measure.

- **Economic feasibility** – If the potential control is determined to be technologically feasible, it is then evaluated for economic feasibility. The District has evaluated the economic feasibility of various control measures by conducting cost

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[7] EPA. 40 CFR 63 – Maximum Achievable Control Technology (MACT). Retrieved from http://www.tceq.state.tx.us/permitting/air/rules/federal/63/63hmpg.html
[8] California Air Resources Board (CARB). Airborne Toxic Control Measures (ATCMs). Retrieved from http://www.arb.ca.gov/toxics/atcm/atcm.htm
[9] 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
[10] Bay Area Air Quality Management District (BAAQMD). Rules and Regulations. Retrieved from http://www.baaqmd.gov/Divisions/Planning-and-Research/Rules-and-Regulations.aspx
[11] Sacramento Metropolitan Air Quality Management District (SMAQMD). Rules and Regulations. Retrieved from http://www.airquality.org/rules/
[12] Ventura County Air Pollution Control District (VCAPCD). Rules and Regulation. Retrieved from http://www.vcapcd.org/Rulebook/RuleIndex.htm

effectiveness analyses within this appendix. 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. EPA cautions that the threshold for economic feasibility should be addressed on a case-by-case basis.

Additional Emission Reduction Opportunities

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

- Any emission reduction opportunities identified/considered in previously adopted District Plans that were determined to be beyond reasonably available control technology (RACT) 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/MSM identified were then thoroughly evaluated for technological and economic feasibility, as previously defined. 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/MSM.

Evaluation Findings

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

C.1 Rule 4103 (Open Burning)

Discussion

Historically, the practice for disposing of agricultural materials has been through the open burning of the materials in the field. Burning agricultural materials provided an economically feasible method for the timely disposal of these materials, helped prevent the spread of plant diseases, and controlled weeds and pests. The air quality impacts from open burning in the Valley have long been a significant concern for the District and Valley growers, and numerous measures have been successfully implemented over the years to minimize these impacts.

Rule 4103 was originally adopted on June 18, 1992, to regulate and coordinate the use of open burning while minimizing smoke impacts on the public. Rule 4103 has since been amended seven times and become progressively more stringent. In 2003, California Senate Bill (SB) 705 (CH&SC Section (§) 41855.5 and 41855.6) established a schedule to phase-out the open burning of agricultural material but provided for a postponement of the phase-out where justified by technical and economic impediments. The phase-out requirements of SB 705 have been incorporated into Rule 4103 and were implemented beginning June 1, 2005. The District also operates a comprehensive Smoke Management System (SMS) to manage open burning and only allow the limited amount of burning that is still permissible to take place on days with favorable meteorology and in amounts that will not cause a significant impact on air quality. Due to the management of open burning under the District's comprehensive SMS, modeling conducted as part of this Plan demonstrates that this source category does not significantly contribute to attainment of the applicable PM2.5 standards.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	2.27	2.25	2.24	2.23	2.23	2.22	2.22	2.21	2.21
NOx	1.60	1.59	1.58	1.57	1.57	1.57	1.56	1.56	1.55
	Winter Average - Tons per day								
PM2.5	3.46	3.44	3.42	3.41	3.40	3.40	3.39	3.38	3.37
NOx	2.44	2.42	2.40	2.39	2.39	2.38	2.38	2.37	2.36

Source Category

The San Joaquin Valley, in adherence with SB 705, has the toughest restrictions on agricultural burning in the state. Rule 4103 was last amended on April 5, 2010, to incorporate the final provisions of SB 705 phase-out schedule directly into the rule to more efficiently allow the District, with the concurrence of ARB, to consider the feasibility of non-burning alternatives for specific crops and materials and postpone burn prohibitions where it is determined there are no feasible alternatives.

Through Rule 4103, the District no longer allows the burning of field crops (with the exception of a certain percentage of rice), prunings (with the exception of pome fruit prunings, and a limited amount of surface harvested pruning acreage), and orchard removals (with the exception of small acreage removals, vineyard removals, pome fruit removals, and citrus removals). A limited amount of additional burning is allowed for disease prevention, noxious weeds, ditch banks and canals, ponding and levee banks, and diseased beehives provided rule requirements are met and meteorological conditions are appropriate.

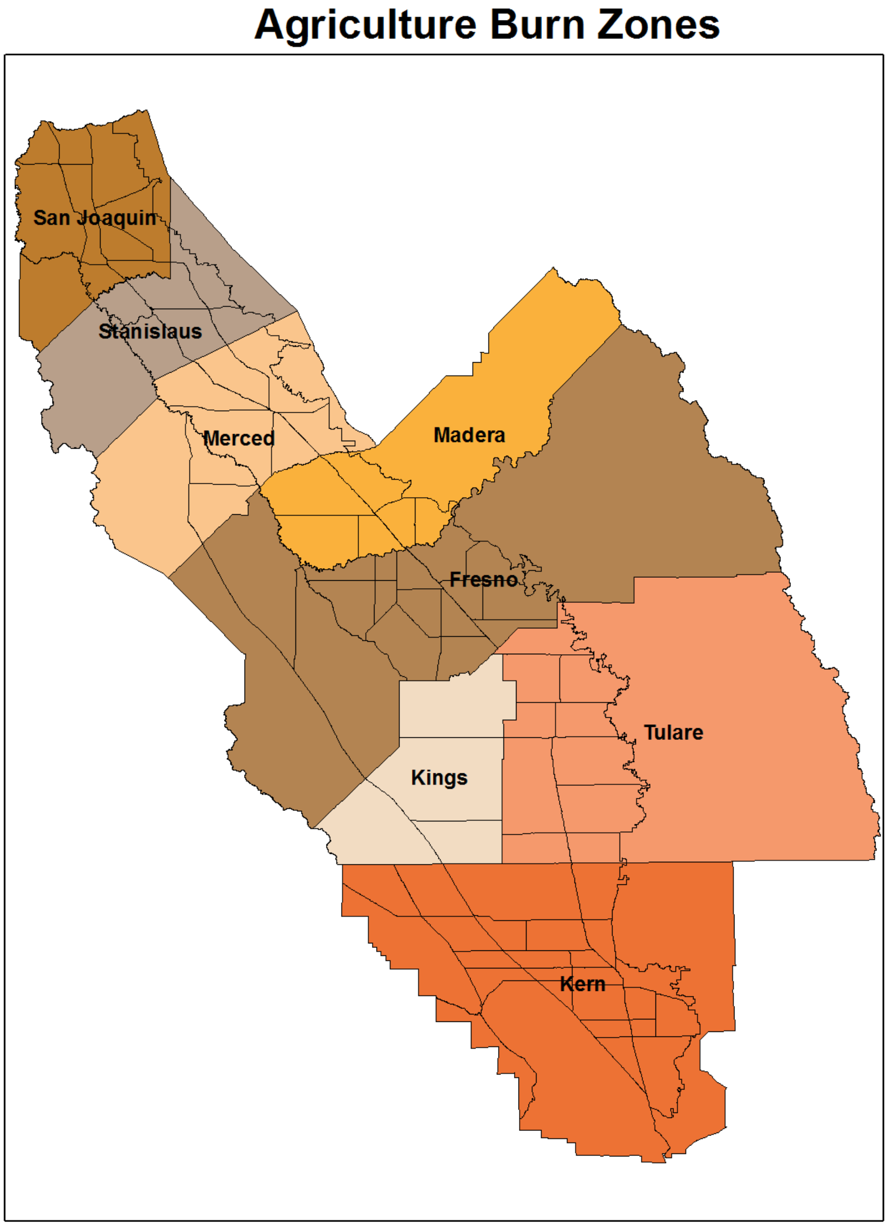
Rule 4103 also contains requirements for collecting, sorting, drying, and igniting agricultural materials; the timing, monitoring, and maintenance of burns; and specific requirements for field crop burning, ditch bank and levee maintenance, contraband materials, Russian thistle (tumbleweeds), and diseased materials. Additionally, the rule details a set of conditions that must be met for a burn permit to be issued.

Smoke Management System (SMS)

The District uses the SMS to manage the Valley's remaining open burning of agricultural crops and materials. On a daily basis, the District analyzes projected local meteorology, the air quality conditions, the atmospheric holding capacity, the amount of burning already approved in a given area, and the potential impacts on downwind populations. Through the results of this daily analysis, the District uses the SMS to manage 97 Valley burn zones (see Figure C-1) and allocates daily burning allowances if appropriate. This approach ensures the District limits the distribution of air pollutant emissions from open burning temporally and spatially, providing flexibility of burn days for growers while minimizing the impact on the public.

Properly managed burning allocations under the SMS ensures that air quality, health impacts, and public nuisance from open burning of agricultural materials are minimized to the fullest extent feasible.

Figure C-1 Agricultural Burn Zones Defined in the District SMS



HOW DOES DISTRICT RULE 4103 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There are no EPA CTG, ACT, NSPS, NESHAP, or MACT requirements for this source category.

State Regulations

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

The requirements of the above state regulations are implemented through Rule 4103. The District has continued to work closely with Valley stakeholders to identify feasible alternatives to open burning of various agricultural materials and to meet its legal obligation under state law. Unlike other areas of the state that are prohibited from banning agricultural burning[13], the District is required to phase-out agricultural burning in accordance with CH&SC §41855.5, and has done so for most crop categories. 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 ARB concurs[14]. 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 prepared three reports on agricultural burning activities in the Valley since 2010. The 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 the Senate Bill.

- *2010 Final Staff Report and Recommendations on Agricultural Burning.* After working extensively with stakeholders to understand viable alternatives to open burning and the associated costs, the District provided recommendations for allowing or prohibiting the open burning of specific agricultural material categories. ARB provided a 2-year concurrence on District recommended postponements, based on the lack of feasible alternatives to open burning.
- *2012 Update: Recommendations on Agricultural Burning.* The 2012 report showed that in the two years since the 2010 report, there had been no significant changes in the economic feasibility of alternatives to agricultural burning, the amount of agricultural materials accepted at biomass facilities continued to fluctuate based on market conditions, and there were no long-term federal or state funding commitments for the operation of biomass facilities or development of alternatives to burning. ARB provided an additional 3-year concurrence on the District recommended postponements, based on the continued lack of feasible alternatives to open burning.
- *2015 Agricultural Burning Review.* The 2015 report demonstrated continued lack of feasible alternatives, a failing biomass industry resulting in less acceptance of agricultural materials, and a continued lack of long-term federal or state funding

[13] CH&SC §41850 requires that "agricultural burning be reasonably regulated and not prohibited."
[14] CH&SC §41855.6

commitments for the operation of biomass facilities of development of alternatives to open burning. ARB concurred with the District's findings.

The next report will be conducted in 2020. This analysis will contain a comprehensive analysis of the feasibility of alternatives to open burning for different crop categories, including costs and availability of emerging technologies. Once completed the report will be submitted to ARB for their review and concurrence.

HOW DOES DISTRICT RULE 4103 COMPARE TO RULES IN OTHER AIR DISTRICTS?

BAAQMD

- BAAQMD Regulation 5 (Open Burning) *(Amended June 19, 2013)*

	SJVAPCD	BAAQMD
Applicability	Open burning conducted in the San Joaquin Valley Air Basin, with the exception of prescribed burning and hazard reduction burning (regulated under District Rule 4106)	Open burning in the BAAQMD
Exemption	Fires used for cooking, campfires, and religious fires where the fuel is clean, dry wood or charcoal are exempt. Emergency burning by a fire agency, the respectful burning of an unserviceable American flag, bags used for agricultural chemicals, and raisin trays are also exempted. Specific exemptions and provisions for burning contraband and emergency ag 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; the use of flame cultivation when the burning is performed with LPG or natural gas-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 for crops covered by Section 5.5.2: 5.5.1.1 Field Crops,	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

	SJVAPCD	BAAQMD
	5.5.1.2 Prunings, 5.5.1.3 Weed Abatement, except for categories covered by Section 5.5.3, 5.5.1.4 Orchard Removals, 5.5.1.5 Vineyard Removal Materials, 5.5.1.6 Surface Harvested Prunings, and 5.5.1.7 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	(hazard reduction burning), fire training, flood debris, irrigation ditches, flood control, range management, forest management, marsh management, contraband, filmmaking, and public exhibition.

SCAQMD

- SCAQMD Rule 444 (Open Burning) *(Amended July 12, 2013)*

The District evaluated the requirements contained within SCAQMD's Rule 444 and found no requirements that were more stringent than those already in Rule 4103. SCAQMD Rule 444 was last amended on July 12, 2013 to expand rule applicability to include beach burning. The amendments apply to sources that do not exist within District's boundaries, and therefore are unnecessary to be required in the Valley to satisfy BACM or MSM requirements. Rule 444 also restricts burning on residential wood combustion curtailment days. This is a practice that has already been implemented by the District through the Smoke Management System procedures, and which is also included in District Rule 4103, Section 5.2, whereby "the APCO 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 cause a public nuisance, impact smoke sensitive areas, or create or contribute to an exceedance of an ambient air quality standard." District Rule 4103 is as stringent as, or more stringent than, SCAQMD Rule 444.

	SJVAPCD	SCAQMD
Applicability	Open burning conducted in the San Joaquin Valley Air Basin, with the exception of	Agricultural burning, Disposal of Russian thistle, Prescribed burning, Fire prevention/suppression training,

	SJVAPCD	SCAQMD
	prescribed burning and hazard reduction burning	Open detonation or use of pyrotechnics, Fire hazard removal, Disposal of infectious waste, other than hospital waste, Research of testing materials, equipment or techniques, Disposal of contraband, Residential burning, Beach burning
Exemption	Fires used for cooking, campfires, and religious fires where the fuel is clean, dry wood or charcoal are exempt. Emergency burning by a fire agency, the respectful burning of an unserviceable American flag, bags used for agricultural chemicals, and raisin trays are also exempted. Specific exemptions and provisions for burning contraband and emergency ag burns that would cause economic loss if denied.	Fire suppression training by fire agencies, open burning to protect crops from freezing (requires emergency burn plan to be submitted), open burning on islands located 15 miles or more from the mainland, fireworks displays, explosives detonation, recreational fires/ceremonial fires. Food prep fires and fires “for warmth at social gatherings” are allowed.
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 for crops covered by Section 5.5.2: 5.5.1.1 Field Crops, 5.5.1.2 Prunings, 5.5.1.3 Weed Abatement, except for categories covered by Section 5.5.3, 5.5.1.4 Orchard Removals, 5.5.1.5 Vineyard Removal Materials, 5.5.1.6 Surface Harvested Prunings, and	No specific crop phase-outs or bans burning of waste/garbage is prohibited. No burning unless it is a permissive burn day or a marginal burn day on which burning is permitted in the applicable source/receptor area and such burning is not prohibited by the applicable public fire protection agency. Specific requirements for burn authorization requests and permit conditions for each category of burning (similar to SJV).

	SJVAPCD	SCAQMD
	5.5.1.7 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	

SMAQMD

- SMAQMD Rule 501 (Agriculture Burning) *(Amended April 3, 1997)*

The District evaluated the requirements contained within SMAQMD's Rule 501 and found no requirements that were more stringent than those already in Rule 4103.

	SJVAPCD	SMAQMD
Applicability	Open burning conducted in the San Joaquin Valley Air Basin, with the exception of prescribed burning and hazard reduction burning	Agricultural burning, including: ag waste (trees, prunings, rice straw and stubble, field crop residue) disease prevention, range improvement, wildlife/game habitat, irrigation system management, forest management, wild land vegetation management, paper containers of ag chemicals
Exemption	Fires used for cooking, campfires, and religious fires where the fuel is clean, dry wood or charcoal are exempt. Emergency burning by a fire agency, the respectful burning of an unserviceable American flag, bags used for agricultural chemicals, and raisin trays are also exempted. Specific exemptions and provisions for burning contraband and emergency ag burns that would cause economic loss if denied.	Similar exemptions as SJV for ag operations, including burning of bags used for agricultural chemicals and emergency agricultural burns which would cause economic loss if denied.

	SJVAPCD	SMAQMD
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 for crops covered by Section 5.5.2: 5.5.1.1 Field Crops, 5.5.1.2 Prunings, 5.5.1.3 Weed Abatement, except for categories covered by Section 5.5.3, 5.5.1.4 Orchard Removals, 5.5.1.5 Vineyard Removal Materials, 5.5.1.6 Surface Harvested Prunings, and 5.5.1.7 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 (subject to air basin-wide rice burning reduction) Permit holder must contact District for permission to burn and ensure that it is not a No Burn day, and must contact the fire protection agency having jurisdiction over the burn location. Specific drying time requirements for different ag materials (similar to SJV)

VCAPCD

- VCAPCD Rule 56 (Open Burning) *(Amended November 11, 2003)*
- The District evaluated the requirements contained within VCAPCD's Rule 56 and found no requirements that were more stringent than those already in Rule 4103.

	SJVAPCD	VCAPCD
Applicability	Open burning conducted in the San Joaquin Valley Air Basin, with the exception of prescribed burning and hazard reduction burning	Combustible materials in open outdoor fires
Exemption	Fires used for cooking, campfires, and religious fires where the fuel is clean, dry wood or charcoal are exempt. Emergency burning by a fire agency, the respectful burning of an unserviceable American flag, bags used for agricultural chemicals, and raisin trays are also exempted. Specific exemptions and provisions for burning contraband and emergency ag burns that would cause economic loss if denied.	This rule shall not apply to open outdoor fires used only for the heating or cooking of food for human consumption or for recreational purposes when such fires are confined to a fireplace or barbecue pit. Flag burning, fire suppression training, fire agency/public officer allowed to set fires to reduce hazards as needed (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 for crops covered by Section 5.5.2: 5.5.1.1 Field Crops, 5.5.1.2 Prunings, 5.5.1.3 Weed Abatement, except for categories covered by Section 5.5.3, 5.5.1.4 Orchard Removals, 5.5.1.5 Vineyard Removal Materials,	No specific crop phase-outs or bans Permit required for open burning, burning only allowed on permissive burn days. Open burning is allowed for the following purposes only: a. The disposal of agricultural wastes in the pursuit of agricultural operations. b. Range improvement burning. c. Wildland vegetation management burning. d. Levee, reservoir or ditch maintenance. e. The disposal of Russian thistle (*Salsola kali* or tumbleweed).

	SJVAPCD	VCAPCD
	5.5.1.6 Surface Harvested Prunings, and 5.5.1.7 Other Materials. Additional requirements for burning times, drying times. 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	Specific burn times, drying times, and permit conditions also specified (similar to SJV).

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

As demonstrated above, in adherence with applicable state laws instituted under SB705, the San Joaquin Valley has the toughest restrictions on agricultural burning in the state. The District regulations have phased-out the burning of all field crops (with the exception of rice), almost all prunings, and almost all orchard removals.

Until 2014, the restrictions imposed by the District resulted in an 80% reduction in the open burning of agricultural waste in the Valley. The exceptional drought conditions that the Valley experienced from 2012 to 2016 resulted in hundreds of thousands of acres of orchards, vineyards and other agricultural crops being fallowed or removed. These conditions, paired with the demise of the biomass industry which had previously provided the primary alternative to agricultural burning for a significant amount of the agricultural waste generated in the Valley, has created a severe waste disposal issue. Additionally, there are currently no long-term federal or state funding commitments to support the operation of biomass facilities or development of alternatives to open agricultural burning. The combination of these factors has resulted in an increase in open burning over the past several years and threatens the District's ability to continue to maintain broad restrictions on open burning of agricultural waste into the future due to the lack of feasible alternatives capable of handling the volume of agricultural waste generated in the Valley each year.

Finding technologically feasible, cost-effective alternatives to open burning of agricultural waste is mandated by law if the current prohibitions are to be retained. Under CH&SC Section 41855.6, the District may postpone burn restrictions for any category of agricultural waste crop where all the following apply:

- There is no economically feasible alternative means of eliminating the waste

- There is no long-term federal or state funding commitment for the continued operation of biomass facilities or development of alternatives to burning
- The continued issuance of burn permits will not cause or substantially contribute to a violation of any air quality standard

As noted above, biomass power plants have historically provided the main alternative to the open burning of agricultural waste. Biomass burning of agricultural material has been preferable to open burning as it combusts the material more completely, results in fewer emissions, and provides an alternative source of renewable energy in the Valley.

Disposal of Ag Materials Severely Impacted by Biomass Power Plant Shutdowns

The biomass industry is primarily the product of the Public Utility Regulatory Policy Act (PURPA) which was enacted in 1978 at the height of the energy crisis to promote the use of alternative nonutility power generation. Today, these facilities are fully depreciated and have lost, or are nearing the ends of, their long-term contracts to sell their power to the utilities. In addition, biomass facilities are facing numerous obstacles to remain in operation including price disadvantage, demand for intermittent power instead of baseload power, and lack of federal and state funding.

Much has changed in the energy markets since PURPA was implemented. Natural gas has replaced oil for electricity generation, and supplies of natural gas have increased, driving down the wholesale cost of electricity. California has adopted a Renewable Portfolio Standard (RPS) that requires 33% of the power that is purchased by utilities be renewable. This has driven competition to fill the renewable energy needs of the state. Under the RPS, Investor Owned Utilities (IOUs) have tended to favor lower cost intermittent sources of renewable power, such as solar and wind. This has left the biomass industry in a position where the power that they produce is not desirable, since most biomass plants provide baseload power instead of intermittent power, and the current rate being paid for power does not allow them to remain viable.

Given the current energy policy, the biomass industry does not compete well under the current procurement policies of the state's IOUs. Historically, the biomass facilities have demanded 12-13 cents per kilowatt-hour, which has been necessary to retain economic viability. Pricewise, this places biomass facilities at a competitive disadvantage with other renewable fuels that can be procured at a much lower cost. Under the state's RPS, program pricing information is confidential, however, anecdotal evidence is that currently the IOUs are purchasing power from solar and wind facilities at approximately 8 cents per kilowatt-hour.

Another factor that negatively impacts the competitive position of biomass generated power is the fact that such plants provide "baseload" power. As baseload generators, biomass facilities cannot produce power that can be turned on quickly, and therefore, cannot meet the power system's demand for "ramping services". The demand for ramping services is compounded by continued increase in the use of wind and solar renewable sources, which is partially triggered by the state's RPS goals. If current trends persist, this issue will worsen in the future. It is estimated that by 2020, solar and wind will account for three-quarters of the state's renewable power and 20% of the state's total electricity supply. The net effect of this is a further transition away from baseload generators to more flexible generators that can be turned-on and turned-off when needed. Under this scenario, not only do biomass facilities have difficulty competing directly on price, but they also do not provide the type of power that is desired. While under this scenario the state can meet its renewable power goals, the potential loss of biomass plants can impact the state's broader greenhouse gas reduction goals under AB 32 by increasing GHG emissions in sectors that currently rely on biomass plants for disposal of materials including the agricultural industry, landfills, and forests.

The biomass industry has long relied on a combination of state and federal financial incentives to directly support their relatively higher production costs. These incentives have ranged from tax credits to monetary grants, which have all expired over the last decade. Examples of these programs include the federal Renewable Electricity Production Tax Credit (expired in 2013), the state Existing Renewable Facilities Program (expired in 2011), and the state Biomass-to-Energy incentive Grant Program (expired in 2003). With the expiration of these programs, there are currently no long-term federal or state funding commitments for the operation of biomass facilities.

Since 2012, six Valley biomass facilities have shut down operations and now only five remain in operation. In 2015, the District took actions aimed at short- and long-term measures to alleviate the effect on agricultural growers of the biomass capacity shortfall in the Valley and to identify other alternatives to agricultural open burning. The District convened a workgroup with agricultural representatives to explore and advance waste disposal techniques as alternatives to open burning and traditional biomass power plants. In addition, the District requested that the Governor direct the California Public Utilities Commission to recognize the societal benefits of existing biomass facilities and their role in reducing emissions from agricultural open burning, and to extend Power Purchase Agreements with existing biomass facilities at current pricing levels.

Traditional biomass power plants need significant funding and legislative support, both of which are in short supply given state's current energy policies. The industry is on life support and is receiving some limited assistance due to the Governor's proclamation that ordered CPUC and California Energy Commission to enter into contracts with existing bioenergy facilities to take feedstock from high hazard zones. The District has not supported this approach as it shifts emissions from high altitude forests to the communities on the Valley floor. Further complicating the issue for traditional biomass power plants is the opposition they face from local communities. Many of these facilities are located in or near disadvantaged communities and community members and advocates have been critical of the emissions from these plants being concentrated in these communities.

Beyond Most Stringent Measures: District Efforts to Advance Alternatives

The loss of Valley biomass facilities has considerably reduced the available options to dispose of agricultural wood waste. Additionally, the extreme drought conditions that the Valley experienced from 2012-2016 resulted in hundreds of thousands of acres of orchards, vineyards and other agricultural crops to be fallowed or removed and replaced with other crops. As a result, many agricultural growers have lost the primary economically feasible disposal option for agricultural material and there has been an extreme build-up of agricultural waste material in the Valley.

As a part of District efforts to identify and advance cleaner alternatives to open burning of agricultural waste, in November of 2017 the District held the Central Valley Summit on Alternatives to Open Burning of Agricultural Waste to bring together Valley growers, researchers/experts, representatives from the biomass power industry, representatives from new and developing technology vendors, and Valley stakeholders. The Summit demonstrated that additional research and resources are necessary to propel forward several emerging technologies and practices which may offer feasible alternatives to open burning in the future.

The District has identified soil incorporation of woody biomass, composting, various scales of biomass-to-power technologies, and air curtain burners as potential measures which were evaluated for technological and economic feasibility of implementation in the Valley. These measures will be further discussed below.

<u>Composting</u>

District evaluation of composting has shown that composting is not technologically feasible as a large-scale alternative to open burning. Aggressive state policy designed to divert urban organic waste from landfills has led to the need to significantly expand composting infrastructure to meet legislative deadlines, limiting the ability of composting facilities to accommodate increased woody material from agricultural operations. Implementing composting solutions, either on farm or at local compost facilities, face permitting challenges and regulatory impediments as these operations increase VOC and methane emissions, and may pose water quality risks as well if not properly controlled and mitigated.

There are also cost-effectiveness issues which would need to be addressed in using large scale composting to process agricultural waste. The costs of landfilling or composting the agricultural material involves transporting the material off-site to a landfill or composting site that will accept them. A local bio solids compost site indicated that some agricultural waste would be acceptable for composting; however, they do not have space for any of this material at present. A compost operator in Kern County indicated that the problem for composters is a shortage of nitrogenous materials (and water). Taking on more wood waste (a carbonaceous material) would only make the carbon to nitrogen ratio worse (i.e., higher), hence, it would be unlikely that any composters would accept this material at any price due to the current surplus of woody material in the Valley.

<u>Advanced Biomass to Power Technologies</u>

Next generation bioenergy solutions appear to be on the verge of broader deployment, but currently do not present a feasible alternative to open burning. While advancements in bioenergy solutions are moving rapidly and technologies are becoming closer to broader deployment, more certainty about the availability of pipeline or electrical interconnection is necessary to assist with securing investments needed to get these projects off the ground. The Central Valley Summit included representatives from a broad range of technologies which included on-farm, off-site and transportable solutions covering large- and small-scale electrical power production, renewable natural gas pipeline injection, and transportation fuel production.

Cellulosic ethanol is an advanced next-generation biofuel that can be made from agricultural wastes, wood chips, switch grass, corn stover, forest wastes, fast-growing trees, and other plant material. Currently, ethanol produced in the United States is most commonly produced from corn kernels. In the United States, corn ethanol is primarily used as an alternative or additive to gasoline. Advanced biofuels are those that do not rely on the starch in corn kernels. Production of large quantities of ethanol from woody biomass will likely require the use of chemical treatment or enzymes to speed the breakdown of the cellulose in the biomass. Currently, the production of cellulosic ethanol is still in the demonstration phase of development.

Pyrolysis is a possible path to convert agricultural biomass to higher value products. Pyrolysis is the heating of an organic material, such as biomass, in the absence of oxygen. It is the first step of producing a flammable gas called synthetic gas (syngas). Burning syngas to produce power offers certain advantages over directly burning the biomass because the gas can be cleaned and filtered to remove problematic chemical compounds. Using syngas is also potentially more efficient than direct combustion of biomass because the gas can be combusted at higher temperatures. Syngas can also be used to produce methanol and hydrogen, or converted into a liquid fuel. This is a viable alternative for farm-scale or small-scale power production, with lower emissions than existing biomass combustion power plants. There are currently only a few operational units in California, including two in the Valley.

Gasification/Cogeneration Plant Cost Data:
The International Renewable Energy Agency (IRENA) publication titled “Renewable Energy Technologies: Cost Analysis Series (June 2012), includes costs for gasification technologies. The following rough cost estimates were derived from the data included in the IRENA publication.

Equipment Type	Approximate Capital Cost (including installation, equipment, site upgrades)	Annual Maintenance and Operating*	Fuel Cost (including Transportation)**
Gasifier Powering a 50 MW Gas Turbine ~650 short tons/day of biomass fuel	$57,805,000	$2,601,225/year	$3,153,000/year
Gasifier powering a 4 MW ICE	$1,778,400	$80,028/year	$158,080/year

Equipment Type	Approximate Capital Cost (including installation, equipment, site upgrades)	Annual Maintenance and Operating*	Fuel Cost (including Transportation)**
~50 tons/day of biomass fuel			
Gasifier Powering a 600 kW CHP system ~8 tons/day of biomass fuel	$907,200	$40,824/year	$59,875/year

*Pursuant to the publication, the annual maintenance and operating cost ranges from 3% to 6% of the Capital Cost. 4.5% was used to estimate the annual maintenance and operating costs (which don't include the fuel and fuel transportation costs).
** Fuel and transportation costs vary greatly from one country to the next and one site to the next. Therefore, the accuracy of the estimate from the IRENA document may not be entirely accurate for the valley.

Due to the high cost of the purchase and installation of these technologies, most of these types of projects have required funding from state, local, and federal governments. Questions remain as to whether these projects would be self-sustaining over the long term without incentives.

The District will make every effort to support the deployment of new technologies through incentive programs. Additionally, the District has an ongoing Technology Advancement Program solicitation to support the commercialization of technologies that provide alternatives to the open burning of biomass.

Air Curtain Burn Boxes

Air curtain burn boxes may serve as a viable alternative to reducing emissions from open burning of agricultural waste. Air curtain burn boxes have been shown to be up to 80% cleaner than open burning of wood waste, and when coupled with the District's smoke management systems have the potential to manage emissions from the disposal of agricultural waste very effectively. However, the process rate of these units (1 to 5 tons/hr) may limit the effectiveness of air curtain burn boxes as a feasible alternative capable of handling the volume of agricultural waste generated in the Valley each year as it may take several units operating for multiple days just to process even small acreage removals. Notwithstanding, the District is working to facilitate the use of air curtain burners to dispose of agricultural material under certain scenarios in combination with the District's smoke management systems.

The District will continue to evaluate alternatives to open burning of agricultural waste and will support the implementation of clean alternatives where technologically and economically feasible.

EVALUATION FINDINGS

District Rule 4103 remains more stringent than requirements for analogous rules in other regions and currently meets or exceeds RACM, BACM, and MSM level requirements for this source category. Additionally, due to the management of open burning under the District's comprehensive SMS, modeling conducted as part of this Plan demonstrates that this source category does not significantly contribute to attainment of the applicable PM2.5 standards. District analysis has confirmed for the development of this attainment plan that there continues to be a lack of feasible alternatives for open burning for the crop categories identified and there continues to be a lack of long-term federal and state funding commitments for the continued operation of biomass facilities in the Valley or development of alternatives to open burning as required by state law to phase-out open burning of agricultural waste.

Despite the insignificant effect of this source category on attainment of the applicable PM2.5 standards and the lack of feasible alternatives to open burning, the District intends to maintain the restrictions currently contained within the rule while continuing to undertake efforts aim at the development and deployment of feasible alternative technologies and practices to reduce open agricultural burning in the Valley. The District efforts will be conducted in close coordination with USDA-NRCS, agricultural sources, and researchers through established processes such as the Agricultural Technical Subcommittee. These efforts include the pursuit of the following:

- Continued implementation the District's Smoke Management System safeguards to ensure no adverse air quality impact from authorized agricultural open burning.

- Exploring the feasibility of utilizing air curtain burn boxes subject to the District's Smoke Management System safeguards as an extension of agricultural operations.

- Continued support for state and federal financial assistance to promote cleaner alternatives for the disposal of agricultural waste.

- Continued support and financial assistance as feasible for the emerging cleaner alternatives to the open burning of agricultural waste, with priority given to on-the-farm deployable (minimum or no transportation related emissions) and scalable technologies, considering the full life-cycle of emissions and associated impacts on air quality when assessing the feasibility of alternatives to open burning.

C.2 Rule 4104 (Emissions From The Reduction Of Animal Matter)

Discussion

Adopted in 1992, 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 1200 degrees Fahrenheit or processed in an equally effective manner. Combustion units, the remaining portion of the operation that produces emissions, are regulated by other District rules; as such, those emissions are controlled by, and accounted for, as a part of other District rules.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.03	0.03	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	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	0.03	0.03
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source Category

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 source of concern from this source category is odor, which is minimized through a venturi scrubber, cyclone, or packed bed scrubber for particulate matter control followed by a thermal oxidizer for VOC control. These facilities generally use steam from a boiler (indirect-fired) or a rotary dryer (direct-fired) for their operations, which generates NOx emissions from these combustion units; these combustion units are regulated by other District rules. There are currently seven active permitted units in the Valley.

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

Federal Regulations

There are no EPA CTG, ACT, NSPS, NESHAP, or MACT requirements for 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?

SCAQMD

- SCAQMD Rule 472 (Reduction of Animal Matter)

	SJVAPCD	SCAQMD
Applicability	Any source operation used for the reduction of animal matter.	Any equipment for the reduction of animal matter.
Exemption	Rule 4104 shall not apply to any article, machine, equipment or other contrivance used exclusively for the processing of food for human consumption.	Rule 472 shall not apply to any equipment used exclusively for the processing of food for human consumption.
Requirements	All gases, vapors and gas-entrained effluent from such an article, machine, equipment or other contrivance are incinerated at temperatures of not less than 1200°F for a period of not less than 0.3 seconds;	All gases, vapors and gas entrained effluents from equipment are incinerated at temperatures of not less than 650°C (1202°F) for a period of not less than 0.3 second.

BAAQMD

- BAAQMD Regulation 12 Rule 2 (Rendering Plants)

	SJVAPCD	BAAQMD
Applicability	Any source operation used for the reduction of animal matter.	Plants whose purpose is the reduction of animal matter, commonly referred to as rendering plants.
Exemption	Rule 4104 shall not apply to any article, machine, equipment or other contrivance used exclusively for the processing of food for human consumption.	No exemptions
Requirements	All gases, vapors and gas-entrained effluent from such an article, machine, equipment or other contrivance are incinerated at temperatures of not less than 1200°F for a period of not less than 0.3 seconds;	All gases, vapors and gas-entrained effluents are incinerated at a temperature of not less than 650°C (1202°F) for a period of not less than 0.3 seconds.

SMAQMD

- SMAQMD Rule 410 (Reduction of Animal Matter)

	SJVAPCD	SMAQMD
Applicability	Any source operation used for the reduction of animal matter.	Odors from animal matter reduction facilities by treatment of gases, vapors and gas-entrained effluents.
Exemption	Rule 4104 shall not apply to any article, machine, equipment or other contrivance used exclusively for the processing of food for human consumption.	Rule 410 shall not apply to any article, machine, equipment or other contrivance used exclusively for the processing of food for human consumption.
Requirements	All gases, vapors and gas-entrained effluent from such an article, machine, equipment or other contrivance are incinerated at temperatures of not less than 1200°F for a period of not less than 0.3 seconds;	All gases, vapors and gas-entrained effluents from such an article, machine, equipment or other contrivance are incinerated at temperatures of not less than 650°C (1202°F) for a period of not less than 0.3 seconds

VCAPCD

- VCAPCD Rule 58 (Reduction of Animal Matter)

	SJVAPCD	SMAQMD
Applicability	Any source operation used for the reduction of animal matter.	Any article, machine, equipment or other contrivance for the reduction of animal matter.
Exemption	Rule 4104 shall not apply to any article, machine, equipment or other contrivance used exclusively for the processing of food for human consumption.	Rule 58 shall not apply to processing of food for human consumption.
Requirements	All gases, vapors and gas-entrained effluent from such an article, machine, equipment or other contrivance are incinerated at temperatures of not less than 1200°F for a period of not less than 0.3 seconds;	All gases, vapors and gas entrained effluents from such an article, machine, equipment or other contrivance incinerated at temperatures of not less than 1300 degrees Fahrenheit for a period of not less than 0.4 seconds.

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

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, determining the scrubber medium may take some experimenting on the part of the facility to ensure it does not cause an increase in emissions or violate other District rules. It would also need to be replaced periodically, adding to the cost of upkeep. Thermal oxidizers do not present similar issues. Also, 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 above emissions inventory table.

Regenerative Thermal Oxidizers
The District evaluated the potential opportunity to reduce emissions from facilities by replacing traditional thermal oxidizers with regenerative thermal oxidizers (RTOs) with heat recovery, which is a current practice at some facilities in the Valley. RTO devices use less supplementary fuel. While using less fuel may reduce NOx emissions, this is not necessarily the case. The PM control efficiency is nearly the same for both thermal oxidizers and RTOs, and the total NOx emissions from this category are relatively small given that there are only a few units subject to this rule that are not already subject to other combustion rules limiting NOx emissions. Any new units would be evaluated through the District’s Best Available Control Technology New Source Review requirements.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for the reduction of animal matter. As demonstrated above, Rule 4104 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM and MSM requirements for this source category.

C.3 Rule 4106 (Particulate Matter Emissions From Prescribed/Hazard Reduction Burning)

Discussion

Adopted in June 2001, Rule 4106 incorporates provisions made necessary by Title 17 of the California Code of Regulations. 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 Rule 4106, the District has expended considerable resources to ensure that the ignition of burn projects is only allowed when air quality and dispersion conditions are favorable, reducing health impacts and air quality impacts.

The District works closely with land managers and participates in daily conference calls with Land Management Agencies (LMAs), CARB staff, fire weather meteorologists, and neighboring air districts to discuss potential smoke impacts from wildfires and prescribed burning. This collaborative effort ensures that the ignition of burn projects occurs when air quality and dispersion conditions are favorable, thus lessening the impacts on air quality in the Valley. Once a prescribed burn is commenced, District staff conducts inspections as needed to ensure the burn is conducted properly and determine if smoke is impacting downwind receptors.

The extreme drought experienced in the San Joaquin Valley and across the western United States has made trees in many regions of California susceptible to epidemic infestations of native bark beetles, which are constrained under normal circumstances by the defense mechanisms of healthy trees. These drought conditions and resulting bark beetle infestations across broad areas have caused vast tree mortality throughout several regions of the state. The scale of this tree die-off is unprecedented in modern history, with the United States Forest Service estimating that there are currently over 129 million dead trees across California. This tree die-off is of such a scale that California has reached an all-time high for fire danger and the potential for devastating wildfires.

Air pollution generated from wildfires poses a significant risk to public health as emissions can routinely overwhelm emission reduction efforts in the San Joaquin Valley and result in periods of excessively high particulate matter and ozone concentrations. Wildfires have the potential to generate tremendous emissions, depending on the acreage burned, fuel loading, and fuel type, and can easily exceed the entire emissions inventory in the Valley from stationary, area, and mobile sources. The length of time it takes for these emissions to occur depends on the severity of the wildfire. In addition to causing elevated PM2.5 concentrations, wildfires also generate and transport ozone precursors. When wildfire emissions are combined with the Valley's common summertime high temperatures and stagnant conditions, the potential for the production of peak ground level ozone is elevated.

Due to the tremendous health and safety risks caused by the tree mortality epidemic, in October 2015, the Governor of California issued a state of emergency proclamation. The Governor's proclamation includes provisions to expedite the removal of dead and dying hazardous trees. This proclamation helps to identify high hazard zones for wildfire and falling trees, and also orders state and local agencies to take action to enable removal of hazard trees. Building on the emergency proclamation, in May 2018, the Governor issued an Executive Order which directs state agencies to work to reduce the threat of wildfires through improved forest management and restoration practices. The Order specifically directs CARB and local air districts to reduce barriers for prescribed burning projects and increase opportunities for prescribed burns as a means for reducing fuel loads and the threat of wildfires.

The District is committed to working with land managers and other stakeholders to support the expanded use of prescribed burning. District staff maintains a dialogue with the land managers and other stakeholders to craft and advance workable solutions. Every spring, the District holds the SJV Annual Cooperators' Meeting to provide a forum for the District and land management agencies to review the Unified Guidelines and Procedures for Smoke Management document and to discuss current smoke management issues. The land management agencies assess year-in-review/lessons learned, provide an outlook for the upcoming fire season, and share presentations. The District also actively participates in the Interagency Air and Smoke Council (IASC) and Air and Land Managers (ALM) annual meetings. The IASC meeting provides a forum for air regulators, land managers, and fire managers to discuss air quality and smoke management issues in California. The ALM meeting provides a forum for decision makers to gain a better perspective on federal, state and local issues associated with smoke management in California.

Due to the tree mortality epidemic, the need to reduce fuel across the forests through prescribed burning and mechanical vegetative thinning methods is increasingly important. Effective forest management is critical to improve the health of the forests, as well as to prevent catastrophic air quality impacts from wildfires in the region. The District will continue to advocate for more effective forest management, and is committed to working with land management agencies to facilitate the reduction in forest fuel loads through both prescribed burning and mechanical vegetative thinning.

EMISSIONS INVENTORY

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76	0.76
NOx	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07	0.07
	Winter Average - Tons per day								
PM2.5	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
NOx	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10

Source Category

Rule 4106 is applicable to all rangeland improvement burning, forest management burning, wildland vegetation management burning, and to hazard reduction burning in the wildland/urban interface within the Valley.

Most prescribed burning is conducted by state and federal land managers on public lands, with additional prescribed burning conducted by a variety of local entities, including utilities and private land owners. Similarly, hazard reduction burning occurs in communities that are within the wildland/urban interface, where homes and businesses in the foothills are often surrounded by dry brush. This fuel must be disposed of each year to ensure a barrier of fire protection of 100 feet in all directions.[15] This disposal is usually in the form of burning, and as with prescribed burning, burning is only allowed if the District forecasts favorable meteorological and air quality conditions.

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

Federal Regulations

There are no EPA CTG, ACT, NSPS, NESHAP, or MACT requirements for this source category.

State Regulations

There are no state regulations applicable to this source category.

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

There are no analogous rules for this source category in [list all applicable air districts].

SCAQMD

- SCAQMD Rule 444 (Open Burning***)*** *(Last amended July 12, 2013)*

The District evaluated the requirements contained within SCAQMD's Rule 444 and found no requirements that were more stringent than those already in Rule 4106.

	SJVAPCD	SCAQMD
Applicability	The provisions of this rule shall apply to all prescribed burning, and to hazard reduction burning in wildland/urban interface.	Agricultural burning, Disposal of Russian thistle, Prescribed burning, Fire prevention/suppression training, Open detonation or use of pyrotechnics, Fire hazard removal, Disposal of infectious waste, other than hospital waste, Research of testing materials, equipment or

[15] 100 foot barrier of fire protection required pursuant to California Public Resources Code §4291

		techniques, Disposal of contraband, Residential burning, Beach burning
Exemptions	N/A	Fire suppression training by fire agencies, open burning to protect crops from freezing (requires emergency burn plan to be submitted), open burning on islands located 15 miles or more from the mainland, fireworks displays, explosives detonation, recreational fires/ceremonial fires. Food prep fires and fires "for warmth at social gatherings" are allowed.
Requirements	No burning of garbage or green waste is allowed. 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** Specific requirements for prescribed burn conductors to have taken a prescribed burning smoke management training class approved by the APCO. Additional prescribed burn requirements detailed by project size. **Permits for Hazard Reduction Burning** No Hazard Reduction Burning shall take place without a permit.	Burning of waste/garbage is prohibited. No burning unless it is a permissive burn day or a marginal burn day on which burning is permitted in the applicable source/receptor area and such burning is not prohibited by the applicable public fire protection agency. Specific requirements for burn authorization requests and permit conditions for each category of burning (similar to SJV).

	A Permit shall be valid only on those days during which burning is not prohibited by the CARB, by the District or other designated agencies. Further administrative requirements and Smoke Management Plan requirements are outlined by project size.	

BAAQMD

- BAAQMD Regulation 5 (Open Burning) *Last amended June, 19, 2013)*

The District evaluated the requirements contained within BAAQMD's Regulation 5 and found no requirements that were more stringent than those already in Rule 4106.

	SJVAPCD	BAAQMD
Applicability	The provisions of this rule shall apply to all prescribed burning, and to hazard reduction burning in wildland/urban interface.	Open burning in the BAAQMD
Exemption	N/A	Fires set only for cooking of food for human beings; fires burning as safety flares or for the combustion of waste gases; the use of flame cultivation when the burning is performed with LPG or natural gas-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 green waste is allowed. The District shall allocate burning based on the predicted meteorological conditions and whether the total tonnage to be emitted	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,

	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** Specific requirements for prescribed burn conductors to have taken a prescribed burning smoke management training class approved by the APCO. Additional prescribed burn requirements detailed by project size. **Permits for 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 the CARB, by the District or other designated agencies. Further administrative requirements and Smoke Management Plan requirements are outlined by project size.	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.

SMAQMD

- SMAQMD Rule 501(Agricultural Burning) *(Last amended April 3, 1997)*

Rule 501 applies to the burning of agricultural waste, including forest management and prescribed burning. The District evaluated the requirements contained within SMAQMD's Rule 501 and found no requirements that were more stringent than those already in Rule 4106. Rule 501 was last amended April 3, 1997.

	SJVAPCD	SMAQMD

Applicability	The provisions of this rule shall apply to all prescribed burning, and to hazard reduction burning in wildland/urban interface.	Agricultural burning, including: ag waste (trees, prunings, rice straw and stubble, field crop residue) disease prevention, range improvement, wildlife/game habitat, irrigation system management, forest management, wild land vegetation management, paper containers of ag chemicals
Exemption	N/A	Similar exemptions as SJV for ag operations, including burning of bags used for agricultural chemicals and emergency agricultural burns which would cause economic loss if denied.
Requirements	No burning of garbage or green waste is allowed. 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** Specific requirements for prescribed burn conductors to have taken a prescribed burning smoke management training class approved by the APCO. Additional prescribed burn requirements detailed by project size. **Permits for Hazard Reduction Burning**	Permit holder must contact District for permission to burn and ensure that it is not a No Burn day, and must contact the fire protection agency having jurisdiction over the burn location. Specific drying time requirements for different ag materials (similar to SJV)

	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 the CARB, by the District or other designated agencies. Further administrative requirements and Smoke Management Plan requirements are outlined by project size.	

VCAPCD

- VCAPCD Rule 56 (Open Burning) *(Last amended November 11, 2003)*

The District evaluated the requirements contained within VCAPCD's Rule 56 and found no requirements that were more stringent than those already in Rule 4106.

	SJVAPCD	VCAPCD
Applicability	The provisions of this rule shall apply to all prescribed burning, and to hazard reduction burning in wildland/urban interface.	Combustible materials in open outdoor fires, including prescribed burning
Exemption	N/A	This rule shall not apply to open outdoor fires used only for the heating or cooking of food for human consumption or for recreational purposes when such fires are confined to a fireplace or barbecue pit. Flag burning, fire suppression training, fire agency/public officer allowed to set fires to reduce hazards as needed (similar to SJV).
Requirements	No burning of garbage or green waste is allowed. 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	Permit required for open burning, burning only allowed on permissive burn days. Open burning is allowed for the following purposes only: a. The disposal of agricultural wastes in the pursuit of agricultural operations. b. Range improvement burning.

	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** Specific requirements for prescribed burn conductors to have taken a prescribed burning smoke management training class approved by the APCO. Additional prescribed burn requirements detailed by project size. **Permits for 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 the CARB, by the District or other designated agencies. Further administrative requirements and Smoke Management Plan requirements are outlined by project size.	c. Wildland vegetation management burning. d. Levee, reservoir or ditch maintenance. e. The disposal of Russian thistle (Salsola kali or tumbleweed). Specific burn times, drying times, and permit conditions also specified (similar to SJV). Drying times not applicable to prescribed burns. Requirements for Smoke Management Plans detailed.

PCAPCD

- PCAPCD Rule 301 (Nonagricultural Burning Smoke Management) *(Last amended February 9, 2012)*

The District evaluated the requirements contained within PCAPCD Rule 301 and found no requirements that were more stringent than those already in Rule 4106.

	SJVAPCD	PCAQMD
Applicability	The provisions of this rule shall apply to all prescribed burning, and to hazard reduction burning in wildland/urban interface.	Fire hazard reduction burning, mechanized burners, fires set or permitted by public officers, and right of way clearing, levee, ditch, and reservoir maintenance, to better manage smoke in order to reduce its effects.
Exemption	N/A	Fire hazard reduction burning, recreational or cooking Fires, flag burning, are exempted. Certain burning categories are exempted from drying time requirements.
Requirements	No burning of garbage or green waste is allowed. 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** Specific requirements for prescribed burn conductors to have taken a prescribed burning smoke management training class approved by the APCO.	The only allowable combustibles that can be burned 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 from the District. No burn permit shall be construed to authorize open outdoor fires for any day during when it is a no-burn day, or open burning is prohibited by a fire protection agency for fire control or prevention. Additional requirements for drying times, approved ignition devices, wind direction, 24 hour burn limit, and administrative requirements (similar to SJV).

	Additional prescribed burn requirements detailed by project size. **Permits for 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 the CARB, by the District or other designated agencies. Further administrative requirements and Smoke Management Plan requirements are outlined by project size.	

Additional Emission Reduction Opportunities

Beyond the review of current regulation and rule requirements, the District performed an extensive review of the feasibility of technologies and measures that have been implemented in practice 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. These efforts will assist in further using 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, the fuel buildup can lead to large wildfires that cause the destruction of the very species that were 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 the California Air Resources Board to waive the requirements for portable equipment and certain off-road equipment.

Air Curtain Burners
While air curtain burners are capable of being deployed in some areas of the forest and are a viable alternative to reduce emissions from prescribed burning in some cases, these units are limited in their ability to be a large-scale solution to the management of forest biomass. Forest managers face challenges in being able to locate the units in remote areas, and the equipment and staff time necessary to operate the units makes the wide-spread operation of air-curtain burners economically infeasible for land management agencies. Additionally, to prevent an accidental fire, air curtain burners must be operated in a cleared area, representing further challenges to the broad deployment of this technology. The vast amount of remote acreage and huge number of diseased or dead trees that must be removed from California forests make it infeasible for air curtain burners to be a regulatory requirement or a large-scale alternative to prescribed burning.

Due to the emissions reductions achieved through the use of air curtain burners, the District will support the deployment of air curtain burners for use where feasible. The use of air curtain burners has been hindered by regulatory hurdles at the federal level. EPA has opined that air curtain burners are subject to the federal New Source Performance Standard for Other Solid Waste Incinerators, which only allows exemptions for emergency or disaster relief for up to 8 weeks. To comply with the requirements beyond the 8-week period, the operator must comply with certain emission limitations and obtain a Title V operating permit which adds cost and complexity to the use of these devices. To provide some administrative relief, the District, along with members of the task force, were able to work with EPA to interpret the regulation as not requiring the Title V permits for at least 30 months after the units begin operation. The exemption from Title V Permitting Requirements for Air Curtain Incinerators was sent by letter from EPA to CAPCOA on February 16, 2017. The District will continue to support the use of air curtain burners as an alternative to prescribed burning where feasible.

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 CDC Biomass Plant 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 CEQA 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.

EVALUATION FINDINGS
The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this source category. As demonstrated above, Rule 4354 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category. No further emission reduction opportunities were found. Due to extensive forest mortality and the critical need to reduce the risks of catastrophic wildfires through prescribed burning in the region, District staff is unable to recommend any additional regulatory measures at this time.

As directed by the District’s Governing Board in November 2015, District staff will continue to work to facilitate effective use of prescribed burning as a means to reduce the number and severity of future wildfires. The District will continue to work with local, state, and federal land managers and fire suppression agencies in an ongoing effort to identify gaps in land management and fire suppression policies and practices and develop solutions. The District will support federal and state legislation focused on enhancing and preserving funding for land and forest management. Additionally, the District will support and pursue legislative or administrative initiatives to allow for mechanical removal of forest fuel buildup in high hazard zones.

C.4 RULE 4203 (INCINERATION OF COMBUSTIBLE REFUSE)

DISCUSSION

Rule 4203 limits the concentration of particulate matter emissions based on process weight rates, and prohibits the discharge of visible emissions. The rule was originally adopted on May 21, 1992 and subsequently amended for District rule number reorganization on December 17, 1992. The facility subject to this rule currently implements BACT level requirements which require the mitigation of air pollution to the maximum degree achievable using control technologies like baghouses and lime scrubbers.

EMISSIONS INVENTORY

CEPAM v1.05 shows no annual or winter emissions for this source category, since there is only one facility subject to the rule.

SOURCE CATEGORY

The incineration of combustible refuse source category includes any person, operation, or facility who uses an incinerator or other equipment to dispose of or process combustible refuse by incineration. There is currently one facility in operation in the Valley subject to Rule 4203. This facility uses 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 specific federal guidelines for particulate matter concentrations in terms of NSPS, CTG, ACT, MACT, and NESHAP. EPA BACT standards require the use of a fabric filter or baghouse. District BACT standards are as stringent and require the use of natural gas supplemental fuel with a baghouse.

State Regulations

There are no state regulations applicable to this source category.

HOW DOES DISTRICT RULE 4203 COMPARE TO RULES IN OTHER AIR DISTRICTS?

There are no comparable rules for this source category in BAAQMD or in SMAQMD.

SCAQMD

- SCAQMD Rule 473 (Disposal of Solid and Liquid Wastes) (*Adopted May 7, 1976, no amendments)*

SCAQMD Rule 473 regulates the disposal of solid and liquid wastes by requiring the operator to use a multiple-chamber incinerator or in equipment found by SCAQMD to be equally effective for the purpose of air pollution control. The District evaluated the requirements contained within SCAQMD Rule 473 and found no requirements that were more stringent than those already in District Rule 4203.

	SJVAPCD	SCAQMD Rule 473
Applicability	The provisions of this rule shall apply to any person, operation, facility, incinerator or equipment used to dispose of or process combustible refuse.	Persons who burn combustible refuse in any incinerator except in a multi-chamber incinerator.
Exemption	The provisions of this rule shall not apply to incinerators which have been approved by the governing fire control agency and which are used to dispose of residential rubbish by open burning as permitted by Rule 4103 (Open Burning).	Multi-chamber incinerators
Requirements	- A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of or process combustible refuse by burning, having burning rates greater than 100 pounds per hour, particulate matter in excess of 0.10 grain per cubic foot of gas calculated to 12% of carbon dioxide (CO_2) at dry standard conditions, except as provided in Section 4.3. - A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of or process combustible refuse by burning, having burning rates less than or equal to 100 pounds per hour, particulate matter in excess of 0.30 grain per cubic foot of gas calculated to 12% of carbon dioxide (CO_2) at dry standard conditions, except as provided in Section 4.3. - A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of combustible refuse by burning, particulate matter in excess of 0.10 pounds per 100 pounds of combustible refuse charged. A person meeting this requirement is	(a) A person shall not burn any combustible refuse in any incinerator except in a multiple-chamber incinerator or in equipment found by the Air Pollution Control Officer to be equally effective for the purpose of air pollution control. (b) A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of combustible refuse by burning, having design burning rates greater than 50 kilograms (110 pounds) per hour, except as provided in subsection (d) of this rule, particulate matter in excess of 0.23 gram per cubic meter (0.1 grain per cubic foot) of gas calculated to 12 percent of carbon dioxide (CO_2) at standard conditions averaged over a minimum of 15 consecutive minutes and shall not discharge particles which are individually large enough to be visible while suspended in the

	not required to meet Sections 4.1 and 4.2. - A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of combustible refuse by burning any particles which are individually large enough to be visible while suspended in the atmosphere. 4.5 Any carbon dioxide produced by combustion of any liquid or gaseous fuel shall be excluded from the calculation to 12% of carbon dioxide (CO_2).	atmosphere. Any carbon dioxide (CO_2) produced by combustion of any liquid or gaseous fuels shall be excluded from the calculation of 12 percent of carbon dioxide (CO_2) produced by combustion of any liquid or gaseous fuels shall be excluded from the calculation to 12 percent of carbon dioxide (CO_2). (c) A person shall not discharge into the atmosphere from any equipment whatsoever, used to process combustible refuse, except as provided in subsection (d) of this rule, particulate matter in excess of 0.23 gram per cubic meter (0.1 grain per cubic foot) of gas calculated to 12 percent of carbon dioxide (CO_2) at standard conditions averaged over a minimum of 15 consecutive minutes. Any carbon dioxide (CO_2) produced by combustion of any liquid or gaseous fuels shall be excluded from the calculation to 12 percent of carbon dioxide (CO_2). (d) A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of combustible refuse by burning, having design burning rates of 50 kilograms (110 pounds) per hour or less, or for which an application for permit was filed before January 1, 1972, particulate matter in excess of 0.69 gram per cubic meter (0.3 grain per cubic foot) of gas calculated to 12 percent

		of carbon dioxide (CO2) at standard conditions averaged over a minimum of 15 consecutive minutes and shall not discharge particles which are individually large enough to be visible while suspended in the atmosphere. Any carbon dioxide (CO2) produced by combustion of any liquid or gaseous fuels shall be excluded from the calculation to 12 percent of carbon dioxide (CO2).

VCAPCD

- VCAPCD Rule 57 (Incinerators) *(Last amended January 11, 2005)*

VCAPCD Rule 57 is applicable to equipment used for the disposal of solid or liquid combustible refuse by burning in an incinerator or equipment found by VCAPCD to be equally effective for the purpose of air pollution control. The District evaluated the requirements contained within VCAPCD Rule 57 and found no requirements that were more stringent than those already in District Rule 4203.

	SJVAPCD	VCAPCD
Applicability	The provisions of this rule shall apply to any person, operation, facility, incinerator or equipment used to dispose of or process combustible refuse.	This rule applies to equipment used for the disposal of solid or liquid combustible refuse by burning.
Exemption	The provisions of this rule shall not apply to incinerators which have been approved by the governing fire control agency and which are used to dispose of residential rubbish by open burning as permitted by Rule 4103 (Open Burning).	This rule shall not apply to: 1. Crematoriums 2. Process equipment such as ovens used to remove contaminants or components from a part or assembly.
Requirements	- A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of or process combustible refuse by burning, having burning rates greater than 100 pounds per hour, particulate matter in excess of 0.10 grain per	1. No person shall burn solid or liquid combustible refuse in an incinerator except in a multiple chamber incinerator, or in equipment approved by the APCO and the U.S. Environmental Protection Agency

	cubic foot of gas calculated to 12% of carbon dioxide (CO_2) at dry standard conditions, except as provided in Section 4.3. - A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of or process combustible refuse by burning, having burning rates less than or equal to 100 pounds per hour, particulate matter in excess of 0.30 grain per cubic foot of gas calculated to 12% of carbon dioxide (CO_2) at dry standard conditions, except as provided in Section 4.3. - A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of combustible refuse by burning, particulate matter in excess of 0.10 pounds per 100 pounds of combustible refuse charged. A person meeting this requirement is not required to meet Sections 4.1 and 4.2. - A person shall not discharge into the atmosphere from any incinerator or other equipment used to dispose of combustible refuse by burning any particles which are individually large enough to be visible while suspended in the atmosphere. 4.5 Any carbon dioxide produced by combustion of any liquid or gaseous fuel shall be excluded from the calculation to 12% of carbon dioxide (CO_2).	to be equally effective for the purpose of air pollution control. 2. No incinerator shall discharge particles individually large enough to be visible while suspended in the atmosphere.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this source category. As demonstrated above, Rule 4313 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM and MSM requirements for this source category.

C.5 Rule 4204 (Cotton Gins)

Discussion

Cotton ginning is the process of separating the lint from the seed. Cotton gins have been operating within the San Joaquin 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. Particulate matter emissions are the unwanted by-products 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.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026
	Annual Average - Tons per day									
PM2.5	0.22	0.22	0.24	0.24	0.24	0.25	0.25	0.25	0.26	0.26
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day									
PM2.5	0.35	0.35	0.37	0.37	0.38	0.38	0.39	0.39	0.40	0.40
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source Category

Rule 4204 was adopted on February 17, 2005, as part of the District's strategy to reduce PM10 emissions and satisfy the attainment goals contained in the 2003 PM10 Plan. Rule 4204 limits particulate matter emissions from cotton ginning operations.

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

Federal Regulations

There are no federal CTGs, ACTs, NSPSs, NESHAPs, or MACTs that are specific to cotton gins

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 (Cotton Gins)
- North Carolina Administrative Code (NCAC) Title 15A, Subchapter 2D, Section .0542 (Control of Particulate Emissions from Cotton Ginning Operations)
- South Carolina Air Pollution Control Regulations and Standards (SCAPCR), Regulation 61-62.5, Standard No. 4, Section V (Cotton Gins)
- Oklahoma Department of Environmental Quality (ODEQ), Air Pollution Control, 252:100-23 (Cotton Gins)
- Texas Commission on Environmental Quality (TECQ), Air Quality Standard Permit for Cotton Gin Facilities and Cotton Burr Tub Grinders

New Mexico Administrative Code (NMAC) 20.2.66.1 (Cotton Gins) (Adopted April 7, 2005)

The District compared the requirements of District Rule 4204 with the requirements contained within NMAC 20.2.66.1.

	SJVAPCD 4204	NMAC 20.2.66.1
Applicability	The provisions of this rule shall apply to all cotton ginning facilities within the District.	All persons who intend to construct or modify a cotton ginning facility as defined in this part, except as otherwise provided by this part.
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 shall be exempt from the requirements of Section 5.0.	None specifically identified.

	SJVAPCD 4204	NMAC 20.2.66.1
Requirements	All emission points shall be controlled by 1D-3D cyclones or rotary drum filters. New cyclones or replacement parts of existing 1D-3D cyclones shall have the dimensional characteristics of the Enhanced 1D-3D cyclone, or the 1D-3D with a 2D-2D inlet and an expansion chamber trash outlet.	High Pressure Exhaust: Exhaust shall be controlled by the use of a high efficiency cyclone dust collectors. High efficiency cyclone dust collector means any cyclone collector of the 2D-2D or 1D-3D configuration. Low Pressure Exhaust: Exhausts shall be controlled by the use of screens with a mesh size of 70 by 70 or finer, or the use of perforated condenser drums with holes not exceeding 0.045 inches in diameter, or with equipment of equivalent or higher design efficiency, as determined by the department.

	Driver-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 the 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 the EPA. • After the pile has built up to the height of the trash auger,	Permits shall include a fugitive dust management plan that includes the complete enclosure of the burr hoppers, the control of fugitive dust emissions from inside the gin building, the control of fugitive dust emissions from outside the gin building.

	SJVAPCD 4204	NMAC 20.2.66.1
	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.	
	Requirements for cotton gin dryers are included in District Rule 4309, *Dryers, Dehydrators, and Ovens*.	Opacity and fuel type limitations for fuel burning equipment.

The NMAC regulation requires the use of 2D-2D or 1D-3D cyclones on the exhaust of high pressure systems only while District Rule 4204 requires all systems to be controlled with 1D-3D cyclones. District Rule 4204 also requires that new cyclones be Enhanced 1D-3D cyclones with high control efficiency. Texas A&M reports tested efficiencies of 97% for 1D-3D cyclones up to 99% for Enhanced 1D-3D cyclones. Therefore, District Rule 4204 requirements result in higher PM control efficiency as compared to NMAC regulation requirements.

The NMAC regulation still allows screened enclosures on low pressure air systems while, as mentioned above, District Rule 4204 requires the use of high efficiency cyclone on all air systems. Therefore, the District rule is significantly more stringent with respect to trash systems.

While NMAC requires burr hoppers to be fully enclosed, District Rule 4204 requires that the trash loading area be an enclosure with four sides higher than the trash auger, which is equivalent to the NMAC requirement. In California cotton gins, all burrs (the hard casing around the cotton fiber) are captured in the trash system. District Rule 4204 is more stringent in this area as well.

Therefore, overall, District Rule 4204 is more stringent than the NMAC 20.2.66.1 regulation applying to cotton gin operations.

North Carolina Administrative Code (NCAC) Title 15A, Subchapter 2D, Section 0542 (Control of Particulate Emissions from Cotton Ginning Operations)
(Amended June 1, 2018)

The District compared the requirements of District Rule 4204 with the requirements contained within NCAC 02D.0542.

	SJVAPCD 4204	15A NCAC 02D.0542

Applicability	The provisions of this rule shall apply to all cotton ginning facilities within the District.	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) shall be exempt from the requirements of Section 5.0.	Existing facilities with a maximum rated capacity of less than 20 bales per 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 1D-3D cyclones or rotary drum filters. New cyclones or replacement parts of existing 1D-3D cyclones shall have the dimensional characteristics of the Enhanced 1D-3D cyclone, or the 1D-3D with a 2D-2D inlet and an expansion chamber trash outlet.	<u>High Pressure Exhaust:</u> Control all high pressure exhausts and lint cleaning exhausts with an emission control system that includes: A. one or more 1D-3D or 2D-2D cyclones to achieve 95 percent efficiency; or B. a device with at least a 95 percent efficiency. <u>Low Pressure Exhaust:</u> Control all low pressure exhausts, except lint cleaning exhausts, with an emission control system that includes: A. one or more 1D-3D or 2D-2D cyclones to achieve 90 percent efficiency; or B. a device with at least a 90 percent efficiency.
	Driver-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	Minimize fugitive emissions by designing and maintaining trash systems, the gin yard, and the traffic area according to the guidelines in the regulation.

	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 the 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 the 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.	

The NCAC regulation requires the use of 2D-2D or 1D-3D cyclones while District Rule 4204 requires 1D-3D cyclones. District Rule 4204 also requires that new cyclones be Enhanced 1D-3D cyclones with high control efficiency, which exceeds standard 1D-3D cyclones 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 1D-3D cyclones up to 99% for Enhanced 1D-3D cyclones. Therefore, District Rule 4204 requiring the use of 1D-3D cyclones on all systems and also requiring that new cyclones be Enhanced 1D-3D 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 2D-2D or 1D-3D cyclones and identifies a 90% PM control efficiency. As discussed above, District Rule 4204 requires the use of 1D-3D cyclones or Enhanced 1D-3D cyclones when installing new cyclones. As mentioned, Texas A&M reports tested efficiencies of 97% for 1D-3D cyclones up to 99% for Enhanced 1D-3D cyclones. Therefore, District Rule 4204 requiring the use of 1D-3D cyclones or new Enhanced 1D-3D 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 4 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 Air Pollution Control Regulations and Standards (SCAPCR), Regulation 61-62.5, Standard No. 4, Section V (Cotton Gins) (Amended September 23, 2016)

The District compared the requirements of District Rule 4204 with the requirements contained within SCAPCR 61-62.5, Std4, Section V.

	SJVAPCD 4204	SCAPCR 62.5, Std4
Applicability	The provisions of this rule shall apply to all cotton ginning facilities within the District.	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) shall be exempt from the requirements of Section 5.0.	Existing facilities with a maximum gin stand rated capacity (or documented equipment limitation) of less than twenty (20) bales per hour that do not have cyclones on lint cleaning system exhausts and battery condenser exhausts as of promulgation date of this rule, will not be required to add the emission control devices in paragraph C.2 below to lint cleaning exhausts or battery condenser exhausts if emissions from these exhausts are controlled by fine mesh screens.
Requirements	All emission points shall be controlled by 1D-3D cyclones or rotary drum filters. New cyclones or replacement parts of existing 1D-3D cyclones shall have the dimensional characteristics of the Enhanced 1D-3D cyclone, or the 1D-3D with a 2D-2D 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 (1) or more 1D-3D or 2D-2D cyclones.
	Driver-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	Trash stacker areas shall contain one (1) of the following: a. A three (3) sided enclosure with a roof whose sides are high enough above the opening of the dumping device to prevent wind from dispersing dust or debris; or b. 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.

	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 the 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 the 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.	Minimize fugitive emissions by designing and maintaining trash systems, the gin yard, and the traffic area according to the guidelines in the regulation.

SCAPC Regulation requires the use of 2D-2D or 1D-3D cyclones while District Rule 4204 requires 1D-3D cyclones and also requires that new cyclones be Enhanced 1D-3D cyclones with high control efficiency. Texas A&M reports tested efficiencies of 97% for 1D-3D cyclones up to 99% for Enhanced 1D-3D cyclones. Therefore, District Rule 4204 requirements result in higher PM control efficiency as compared to SCAPC regulation requirements.

The SCAPC 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 4 bales/day), District Rule 4204 is more stringent in this area as well.

While the SCAPC 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. District Rule 4204 is more stringent in this area as well.

Therefore, overall, District Rule 4204 is more stringent than the SCAPC 62.5, Std4 Section V regulation applying to cotton gin operations.

Oklahoma Department of Environmental Quality (ODEQ), Air Pollution Control, 252:100-23 (Cotton Gins) (Adopted February 17, 2017)

The District compared the requirements of District Rule 4204 with the requirements contained within ODEQ 252:100-23.

	SJVAPCD 4204	ODEQ 252:100-23
Applicability	The provisions of this rule shall apply to all cotton ginning facilities within the District.	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) shall be exempt from the requirements of Section 5.0.	No exemption listed.
Requirements	Opacity from cotton gins is limited to less than 20% pursuant to District Rule 4101.	Visible emissions shall not exceed 20% opacity.

	All emission points shall be controlled by 1D-3D cyclones or rotary drum filters. New cyclones or replacement parts of existing 1D-3D cyclones shall have the dimensional characteristics of the Enhanced 1D-3D cyclone, or the 1D-3D with a 2D-2D inlet and an expansion chamber trash outlet.	<u>Low Pressure Exhaust:</u> The use of screens with a mesh size of 70 by 70 or finer (U.S. Sieve), or the use of perforated condenser drums with holes not exceeding 0.045 inches in diameter or equipment of equivalent design efficiency. <u>High Pressure Exhaust:</u> The use of 2D-2D cyclones shall be required for existing gins. Existing gins shall install and use 1D-3D cyclone collectors or equivalent when the capital cost of repair or replacement of the existing 2D-2D cyclone exceeds 50% of the capital cost of a new 1D-3D cyclone. New or modified cotton gins shall utilize a 1D-3D cyclone collector or equipment of equivalent collection efficiency upon commencement of operation.
	Driver-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	For emission control during dumping, burr hoppers at existing gin sites located within the corporate city limits of any city or within 300 feet of two or more occupied establishments must be totally enclosed. All new gin sites shall install and use a total enclosure on the burr hopper.

	• Fugitive PM10 emissions from load-out areas are reduced by an alternative method, which is approved by the APCO and the 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 the 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.	Minimize fugitive emissions by designing and maintaining trash systems, the gin yard, and the traffic area according to the guidelines in the regulation.

The ODEC regulation requires the use of 2D-2D or 1D-3D cyclones on the exhaust of high pressure systems only while District Rule 4204 requires all systems to be controlled with 1D-3D cyclones. District Rule 4204 also requires that new cyclones be Enhanced 1D-3D cyclones with high control efficiency. Texas A&M reports tested efficiencies of 97% for 1D-3D cyclones up to 99% for Enhanced 1D-3D cyclones. Therefore, District Rule 4204 requirements result in higher PM control efficiency as compared to ODEC regulation requirements.

The ODEC regulation still allows screened enclosures on low pressure air systems while, as mentioned above, District Rule 4204 requires the use of high efficiency cyclone on all air systems. Therefore, the District rule is significantly more stringent with respect to trash systems.

Therefore, overall, District Rule 4204 is more stringent than the NCAC 20.2.66.1 regulation applying to cotton gin operations.

Texas Commission on Environmental Quality, Air Quality Standard Permit for Cotton Gin Facilities and Cotton Burr Tub Grinders

The District compared the requirements of District Rule 4204 with the requirements contained within TCEQ Air Quality Standard Permit for Cotton Gin Facilities and Cotton Burr Tub Grinders.

	SJVAPCD 4204	TCEQ, Air Quality Standard Permit for Cotton Gin Facilities and Cotton Burr Tub Grinders
Applicability	The provisions of this rule shall apply to all cotton ginning facilities within the District.	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) shall be exempt from the requirements of Section 5.0.	Replacement or addition of cotton gin stands where no other equipment change or additions are involved
Requirements	All emission points shall be controlled by 1D-3D cyclones or rotary drum filters. New cyclones or replacement parts of existing 1D-3D cyclones shall have the dimensional characteristics of the Enhanced 1D-3D cyclone, or the 1D-3D with a 2D-2D inlet and an expansion chamber trash outlet.	All rotary drum filter, fabric filter, and cyclone collection systems used to control particulate emissions from the cotton gin facilities authorized by this standard permit shall meet the following requirements, as applicable: • fabric filter and drum filter systems shall be designed to meet an outlet grain loading not to exceed 0.01 grains per dry standard cubic foot (combined front half and back half); • cyclone collectors shall be properly sized high efficiency cyclones with a cone length at least twice the diameter of the cyclone.

	Driver-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 the 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 the EPA.	Fugitive emissions from burr hoppers authorized by this standard permit shall be minimized through the use of appropriate operational practices and/or other control methods to prevent visible emissions from traveling off property during trash dumping operations.

	• 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.	
	Requirements for cotton gin dryers are included in District Rule 4309, Dryers, Dehydrators, and Ovens. Requirements for engines are included in District Rule 4702, Internal Combustion Engines.	Fuel type limitations for burners and engines. Emissions and operating hour limits for engines.

Rather than requiring the use of high efficiency control device, TCEQ Regulation requires that devices (rotary drum filter, fabric filter, and cyclone collection systems) used to control PM be properly designed and operated. As opposed to TCEQ Regulation, District Rule 4204 requires the use of 1D-3D cyclones but also requires that new cyclones be Enhanced 1D-3D cyclones with high control efficiency which exceeds standard 1D-3D cyclones control efficiency. Texas A&M reports tested efficiencies of 97% for 1D-3D cyclones up to 99% for Enhanced 1D-3D cyclones.

Therefore, District Rule 4204 is more stringent than the TCEQ regulation applying to cotton gin operations.

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

There are no analogous rules for this source category in SCAQMD, BAAQMD, SMAQMD, and VCAQPCD

Additional Emission Reduction Opportunities

Beyond the review of current regulation and rule requirements, the District performed an extensive review of the feasibility of expanding applicability or removal of exemptions for this source category, technologies and measures that have been implemented in practice in other regions, and potential new technologies and measures that may be feasible for implementation in the near future. Based on this exhaustive review, District staff did not find any additional measures currently available or will be available prior to the 2025 attainment deadline date that could improve the effectiveness of this rule.

Research and PM2.5 Fraction

Research was completed in 2013 by the United States Department of Agriculture Agricultural Research Service (USDA-ARS), in partnership with cotton associations, EPA, ARB, and the District to measure actual PM10 and PM2.5 emissions from stack sources and fugitive emissions in and around several ginning facilities. This research provided emission factors for comparison to previous estimations that are included in emission inventories and provided data for both types of cotton gins currently in use in California. The project was designed to measure emissions from facilities with current emissions control technologies in place and to improve emissions estimations by measurement with the highest quality methods and instruments. The project was not designed to evaluate new technologies or measures to further reduce emissions. Results for the seven gins that were sampled for the project indicate the estimated ratio of PM2.5 to PM10 is approximately 16%.[16] This fraction of PM2.5 to PM10 is lower than indicated in the emissions inventory currently being used. Future research will include particle size analysis of EPA Method 17 samples, and modeling to compare model output and ambient sampling data and develop suggested modeling corrections.

Baghouse

Baghouses are not feasible at cotton gin operations because of the requirements for high volume of air, blinding from the fibrous material, temperature excursions across fabric filters, and introduction of moisture during the ginning operation.

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 volume 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 fpm to 5,000 fpm[17]. Another issue arises when higher-than-average gas volumes and particulate matter impact on bags. This causes bag blinding[18], 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. Excursions above the recommended temperature limit generally shorten bag life considerably. This same affect is obtained when seed cotton is first dried in large driers using heated air to reduce its moisture content, and if the seed cotton requires additional drying, gins will often run it through second or third drier.

Excess moisture is common to cotton grown in the more humid regions of the Cotton Belt, while cottons produced in the Southwest can be too dry because of the region's arid climate. Lack of moisture at ginning can also lower the quality of the fiber and contribute to ginning problems. That is why moisture is added with special humidifier that blow 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.

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[16] United States Department of Agriculture, Agricultural Research Service. (2013). *Characterization of Cotton Gin Particulate Matter Emissions.* Obtained from http://buser.okstate.edu/air-quality/cotton-gin/national-study/.
[17] Reference Agriculture Handbook No. 503 – Cotton Ginners Handbook, July 1977, page 59
[18] 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.

1D-3D Cyclones with Expansion Chamber

Currently, all cotton gins in the Valley are required to operate using a 1D-3D cyclone. There are currently 28 such units and about two thirds of the 1D-3D cyclones used in the Valley have an expanded chamber outlet. Research has shown that an expansion chamber allows for more 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.[19] The USDA study on PM2.5 emissions from cotton gins discussed above, which provided the District with the PM10/PM2.5 ratio for emissions from cotton gins, did not extend to the expected PM2.5 control efficiencies of control devices at cotton gins; therefore, there is 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, the District does not believe that expansion chambers would be a feasible control for PM2.5.

However, Rule 4204 is predominantly a PM10 control measure and does currently require all new cyclones or replacement parts of existing 1D3D cyclones have the dimensional characteristics of an Enhanced 1D3D cyclone, or a 1D-3D with a 2D-2D inlet and an expansion chamber trash outlet. Therefore, to the extent that PM2.5 may be minimally reduced by expansion chambers, all cyclones on cotton gins in the valley will eventually be replaced by either an Enhanced 1D-3D cyclone or a 1D-3D cyclone with an expansion chamber under the current PM10-targetted rule.

Mechanical Conveyance

Mechanical conveyance for the main trash handling system could be a potential opportunity to reduce emissions, but 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 they are able to design the cotton gin around the equipment and space 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 industry representatives and equipment manufacturers, it is not technologically feasible to retrofit existing cotton gins with mechanical conveyance systems to replace existing trash handling equipment.

Plenum Chambers

[19] 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.

Plenum chambers are in use at three cotton gins in the Valley. Plenum chambers are placed upstream of selected cyclones to remove large trash. No study has been found that demonstrates an increase in PM control efficiency with the utilization of a plenum chamber. Cotton ginning facilities that have installed plenum chambers are generally using those devices to reduce wear and tear on the cyclones, thus prolonging the life of the cyclones, and not for increased PM controls.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for cotton gins. As demonstrated above, Rule 4204 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM and MSM requirements for this source category.

C.6 Rule 4301 (Fuel Burning Equipment)

Discussion

Rule 4301 (Fuel Burning Equipment) has a very broad applicability, as it applies to all types of fuel burning equipment in use in the Valley. Since its early adoption in 1992, it has largely been superseded by several District rules with more stringent requirements for specific types of fuel burning equipment. See the control measure evaluations for Rules 4306, 4307, 4308, 4309, 4320, 4352, and 4703 for more specific information about the individual fuel burning equipment source categories.

Emissions Inventory

The emission inventory is not specific to Rule 4301 as it has been superseded by multiple District rules. See control measures for 4306, 4307, 4308, 4309, 4320, 4352, and 4703 for the individual emissions inventories.

Source Category

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). As previously mentioned, Rule 4301 has been superseded by more stringent requirements. See control measures for 4306, 4307, 4308, 4309, 4320, 4352, and 4703 for more specific evaluations about the individual fuel burning equipment sources 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, such as CTG, ACT, NSPS, NESHAP, and MACT. However, several District rules have superseded Rule 4301 with more stringent requirements. Comparisons of those District rules to the applicable federal and state rules are discussed within those control measure evaluations.

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

Rule 4301 have been superseded by more stringent requirements. See Rules 4306, 4307, 4308, 4309, 4320, 4352, and 4703 for more specific evaluations about the individual fuel burning equipment sources categories.

Additional Emission Reduction Opportunities

Several District rules have superseded Rule 4301 with more stringent requirements. Discussion of feasibility of expanding applicability or removal of exemptions are discussed within those control measure evaluations.

Evaluation Findings

The requirements of Rule 4301 have been superseded by more stringent District rules that meet or exceed RACM, BACM, and MSM level requirements. All units subject to this rule are subject to more specific rules and discussed within those control measure evaluations. See Rules 4306, 4307, 4308, 4309, 4320, 4352, and 4703.

C.7 Rule 4306 and 4320 (Boilers, Process Heaters, and Steam Generators Greater than 5 MMBtu/hr)

Discussion

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 oxides of nitrogen (NOx), carbon monoxide (CO), and particulate matter emissions from boilers, steam generators, and process heaters of this size range.

Rule 4320 is the third generation rule for this source category. The first District rule for this source category, Rule 4305 (Boilers, Steam Generators, and Process Heaters) was adopted on December 16, 1993. Rule 4305 was superseded by Rule 4306 (Boilers, Steam Generators, and Process Heaters – Phase 3) on September 18, 2003 to implement a NOx emission reduction control measure from the District's ozone and PM10 attainment plans. Since adoption, Rule 4306 has been amended twice.

The most recent Rule 4306 amendment in October 2008 was initially proposed to lower the NOx limit from 9 ppmv to 6 ppmv for units greater than 20 MMBtu/hr. It was determined that the proposed NOx limits could be accomplished by using selective catalytic reduction (SCR) or a combination of SCR, ultra-low NOx burners (ULNBs), flue gas recirculation (FGR), and/or tuning, thus making the lower limit of 6 ppmv technologically feasible. However, through the public workshop process and additional research it was also determined that most of the units subject to Rule 4306 have already undergone several generations of NOx controls, and consequently, certain applications of SCR may not be cost effective and/or technologically infeasible because of physical limitations at the facilities. As a result of this public process, the lower NOx limits were included in new Rule 4320 and an option was provided in the rule that allows for the payment of an annual emissions fee based on total actual emissions, rather than installation of additional NOx controls, based on each operator's individual business situation. These fees are used by the District to achieve cost effective NOx reductions through District incentive programs, the District's Technology Advancement Program, and other District programs. The previous versions of Rule 4305 and 4306 combined with the implementation of Rule 4320 results in approximately 96% control of NOx emissions from this source category.

Rule 4320 also includes particulate matter control requirements. These requirements are in the form of limits on the sulfur content of fuel burned. During fuel combustion, the sulfur content in the fuel results in sulfur oxide (SOx) emissions. SOx emissions combine with ammonia in the atmosphere to form ammonium sulfate (a particulate). Reducing the sulfur content in the fuel burned results in lower levels of particulate matter generated by the combusting equipment.

The implementation of Rule 4320 does not substitute the requirements of Rule 4306, but enforces requirements supplementary to Rule 4306. As such, this evaluation is applicable to both Rule 4306 and Rule 4320.

EMISSIONS INVENTORY

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	1.24	1.17	1.12	1.10	1.08	1.06	1.04	1.02	1.01
NOx	1.80	1.53	1.39	1.35	1.31	1.26	1.22	1.18	1.14
	Winter Average - Tons per day								
PM2.5	1.22	1.16	1.10	1.08	1.07	1.05	1.03	1.01	0.99
NOx	1.75	1.49	1.36	1.31	1.28	1.23	1.19	1.15	1.11

SOURCE CATEGORY

Facilities with units subject to this rule 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.

To recognize, and better regulate, the operational and technical differences between different types of equipment subject to Rules 4306 and 4320, the different equipment types were separated into several major categories, with different rule requirements, including the following:

- Units with a total rated heat input greater than 5.0 MMBtu/hr to 20.0 MMBtu/hr
- Units with a total rated heat input greater than 20.0 MMBtu/hr
- Oilfield steam generators of all ratings and fuel types
- Refinery units of all ratings and fuel types
- Low-use units limited by a Permit to Operate to an annual heat input greater than 1.8 billion Btu/year but less than or equal to 30 billion Btu/year
- Units at a wastewater treatment facility using less than 50% PUC quality fuel
- Small specialty units operated by a small producer

HOW DO DISTRICT RULES 4306 AND 4320 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations

There are no EPA CTG requirements for this source category.

Alternative Control Techniques (ACT)

- EPA-453/R-93-034 (ACT Document – NOx emissions from Process Heaters)

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.

- EPA-453/R-94-022 (ACTDocument – NOx Emissions from Industrial/Commercial/Institutional Boilers)

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.

- EPA-453/R-94-023 (ACTDocument – NOx Emissions from Utility Boilers)

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.

NSPS

- 40 CFR 60 Subpart D (Standards of Performance for Fossil-Fuel Fired Steam Generators for Which Construction Is Commenced After August 17, 1971)

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)

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)

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.

- NSPS – 40 CFR Subpart J (Standards of Performance for Petroleum Refineries)

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

- NSPS – 40 CFR Subpart Ja (Standards of Performance for Petroleum Refineries for Which Construction, Reconstruction, or Modification Commenced After May 14, 2007

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

NESHAP/ MACT

- 40 CFR 63 Subpart DDDDD (NESHAP for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters)

40 CFR 63 Subpart DDDDD was amended on January 31, 2013 to include new emission limits for PM, CO, and total selective metals (TSM), replace numeric dioxin emission limits with work practice standards, add new subcategories of facilities, and add alternative monitoring approaches for compliance with the PM limit. The PM limit in District Rule 4320 is more stringent for liquid fuels because it only allows liquid fuels to be burned during PUC quality natural gas curtailment periods. It is equivalent to DDDDD for all gasses burned except for gasses exceeding 40 µg/m^3 of mercury.

The District evaluated the requirements contained within the above NESHAP 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?
There are no analogous rules for this source category in [list all applicable air districts].

SCAQMD
- SCAQMD Rule 1146 (Emissions of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters) *(Amended November 1, 2013)*

The District evaluated the requirements contained within SCAQMD's Rule 1146 and found no requirements that were more stringent than those already in Rule 4306 and 4320.

	SJVAPCD	SCAQMD
Applicability	Any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input greater than 5 million Btu per hour.	Boilers, steam generators, and process heaters of equal to or greater than 5 million Btu per hour 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: Burns non-PUC gas no more than 168 cumulative hours in a calendar year plus 48 hours per calendar year for equipment testing; NOx emission do not exceed 150 ppmv.		(1) boilers used by electric utilities to generate electricity; and (2) boilers and process heaters with a rated heat input capacity greater than 40 million Btu per hour that are used in petroleum refineries; and (3) sulfur plant reaction boilers. (4) RECLAIM facilities (NOx emissions only)
Requirements	Category A Units 5-20 MMBtu/hr Except Categories C through G units	9 ppmv standard 6 ppmv enhanced	9 ppmv Excluding digester and landfill gas fired units, and process heaters.
	Category B Units > 20 MMBtu/hr Except Categories C through G units	7 ppmv standard 5 ppmv enhanced	9 ppmv for units <75 MMBtu/hr Excluding digester and landfill gas fired units, and process heaters. 5 ppmv for units ≥75MMbtu/hr Excluding process heaters.
	Category C.1 Oilfield Steam Generators 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	9 ppmv standard 5 ppmv enhanced
	Category C.2 Oilfield Steam Generators >20 MMBtu/hr	7 ppmv standard 5 ppmv enhanced	9 ppmv for units <75 MMBtu/hr 5 ppmv for units ≥75MMBtu/hr
	Category C.3 Oilfield Steam Generators fired on less than 50% PUC quality gas	9 ppmv	25 ppmv for landfill gas fired units 15 ppmv for digester gas fired units
	Category D.1 Refinery Units 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	9 ppmv standard 5 ppmv enhanced
	Category D.2 Refinery Units 20-110 MMBtu/hr	6 ppmv standard 5 ppmv enhanced	9 ppmv for units <75 MMBtu/hr 5 ppmv for units ≥75MMBtu/hr

	Category D.3 Refinery Units >110 MMBtu/hr	5 ppmv	5 ppmv
	Category D.4 Refinery Units fired on less than 50% PUC quality gas	9 ppmv	25 ppmv for landfill gas fired units 15 ppmv for digester gas fired units
	Category E Units with annual heat input >1.8 billion Btu/yr but <30 billion Btu/yr	9 ppmv	For units using 9.0 billion Btu/yr or less, tune up twice a year. For units over that limit, units must meet the following applicable limit: 25 ppmv landfill gas units, 15 ppmv digester gas units, otherwise, for other units: 9 ppmv for units <75 MMBtu/hr, 5 ppmv for units ≥75MMbtu/hr
	Category F Wastewater Treatment Facilities firing on less than 50% PUC quality gas	9 ppmv	15 ppmv for digester gas fired units
	Category G Units operated by a small producer in which the rated heat input of each burner is less than or equal to 5 MMBtu/hr but the total rated heat input of all the burners in a unit is rated between 5 MMBtu/hr and 20 MMBtu/hr, and in which the products of combustion do not come in contact with the products of combustion of any other burner.	9 ppmv	9 ppmv
	General category in SCAQMD Rule NOTE: This is a general category in	5 ppmv to 9 ppmv (as shown in the above categories)	30 ppmv

	SCAQMD's rule that is covered under multiple categories in District Rule 4320		

BAAQMD

- 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)*
- BAAQMD Regulation 9, Rule 10 (Nitrogen Oxides and Carbon Monoxide from Industrial, Institutional and Commercial Boilers, Steam Generators and Process Heaters in Petroleum Refineries) *(Amended May 4, 2011)*
- BAAQMD Regulation 9, Rule 11 (Nitrogen Oxides And Carbon Monoxide from Utility Electric Power Generating Boilers) *(Amended May 17, 2000)*

The District evaluated the requirements contained within BAAQMD Regulation 9 Rule 7, 10, and 11, and found no requirements that were more stringent than those already in Rule 4306 and 4320.

	SJVAPCD	BAAQMD
Applicability	Any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input greater than 5 million Btu per hour.	Regulation 9, Rule 7 Industrial, institutional and commercial boilers, steam generators and process heaters. Regulation 9, Rule 10 Boilers, steam generators, and process heaters, including CO boilers, in petroleum refineries. Regulation 9, Rule 11 Electric power generating steam boilers.
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 cumulative hours in a calendar year plus 48 hours per calendar year for equipment testing; NOx emission do not exceed 150 ppmv.	Regulation 9, Rule 7 Units ≤ 2.0 MMBtu/hr fire on NG Units < 1.0 MMBtu/hr any fuel Process heaters for radiant comfort heating Waste heat recovery boilers Kilns, ovens, dryers for baking, heat treating, cooking, calcining, vitrifying Low fuel use Tune Up, Startup and shutdown Regulation 9, Rule 10 Units ≤ 2.0 MMBtu/hr fire on NG Units < 1.0 MMBtu/hr any fuel Waste heat recovery boilers Units that received an ATC prior to January 5, 1994 Low fuel use

	SJVAPCD		BAAQMD
			Regulation 9, Rule 11 Boilers < 250 MMBtu/hr Startup and shutdown Oil-burn readiness testing Units that operate with a capacity factor of less than 4% annually Heat recovery steam generators
Requirements	Category A Units 5-20 MMBtu/hr Except Categories C through G units	9 ppmv standard 6 ppmv enhanced	Regulation 9, Rule 7 15 ppmv
	Category B Units > 20 MMBtu/hr Except Categories C through G units	7 ppmv standard 5 ppmv enhanced	Regulation 9, Rule 7 20-75 MMBtu/hr – 9ppmv >75 MMBtu/hr – 5 ppmv Regulation 9, Rule 11 >1.75 billion Btu/hr – 10 ppmv 1.5 - 1.75 billion Btu/hr – 25 ppmv
	Category C.1 Oilfield Steam Generators 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	Regulation 9, Rule 7 15 ppmv
	Category C.2 Oilfield Steam Generators >20 MMBtu/hr	7 ppmv standard 5 ppmv enhanced	Regulation 9, Rule 7 20-75 MMBtu/hr – 9ppmv >75 MMBtu/hr – 5 ppmv
	Category C.3 Oilfield Steam Generators fired on less than 50% PUC quality gas	9 ppmv	Regulation 9, Rule 7 30 ppmv
	Category D.1 Refinery Units 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	Regulation 9, Rule 10 Refinery-wide emission rate not to exceed 0.033 lb per MMBtu (27.25 ppmv) based on an operating day average
	Category D.2 Refinery Units 20-110 MMBtu/hr	6 ppmv standard 5 ppmv enhanced	Regulation 9, Rule 10 Refinery-wide emission rate not to exceed 0.033 lb per MMBtu (27.25 ppmv) based on an operating day average

	SJVAPCD		BAAQMD
	Category D.3 Refinery Units >110 MMBtu/hr	5 ppmv	Regulation 9, Rule 10 Refinery-wide emission rate not to exceed 0.033 lb per MMBtu (27.25 ppmv) based on an operating day average
	Category D.4 Refinery Units fired on less than 50% PUC quality gas	9 ppmv	Regulation 9, Rule 10 Refinery-wide emission rate not to exceed 0.033 lb per MMBtu (27.25 ppmv) based on an operating day average
	Category E Units with annual heat input >1.8 billion Btu/yr but <30 billion Btu/yr	9 ppmv	Regulation 9, Rule 7 For units below 9.0 billion Btu/yr, tune up twice a year or meet 30 ppmv For units exceeding 9 billion Btu/yr, units must meet the following limits: 5-20 MMBtu/hr – 15 ppmv 20-75 MMBtu/hr – 9 ppmv >75 MMBtu/hr – 5 ppmv
	Category F Wastewater Treatment Facilities firing on less than 50% PUC quality gas	9 ppmv	Regulation 9, Rule 7 30 ppmv
	Category G Units operated by a small producer in which the rated heat input of each burner is less than or equal to 5 MMBtu/hr but the total rated heat input of all the burners in a unit is rated between 5 MMBtu/hr and 20 MMBtu/hr, and in which the products of combustion do not come in contact with the products of combustion of any other burner.	9 ppmv	Regulation 9, Rule 7 15 ppmv

SMAQMD

- SMAQMD Rule 411 (NOx from Boilers, Process Heaters and Steam Generators) *(Amended August 23, 2007)*

The District evaluated the requirements contained within SMAQMD's Rule 411 and found no requirements that were more stringent than those already in Rule 4306 and 4320.

	SJVAPCD		SMAQMD
Applicability	Any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input greater than 5 million Btu per hour.		Boilers, steam generators and process heaters) fired on gaseous or nongaseous fuels with a rated heat input capacity of 1 million Btu per hour or greater
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 cumulative hours in a calendar year plus 48 hours per calendar year for equipment testing; NOx emission do not exceed 150 ppmv.		Electric utility boilers, Process heaters, kilns, and furnaces where the products of combustion come into direct contact with the material to be heated, Waste heat recovery boilers. Units with low fuel usage
Requirements	Category A Units 5-20 MMBtu/hr Except Categories C through G units	9 ppmv standard 6 ppmv enhanced	15 ppmv
	Category B Units > 20 MMBtu/hr Except Categories C through G units	7 ppmv standard 5 ppmv enhanced	9 ppmv
	Category C.1 Oilfield Steam Generators 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	15 ppmv
	Category C.2 Oilfield Steam Generators >20 MMBtu/hr	7 ppmv standard 5 ppmv enhanced	9 ppmv
	Category C.3 Oilfield Steam Generators fired on less than 50% PUC quality gas	9 ppmv	15 ppmv
	Category D.1 Refinery Units 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	15 ppmv

	SJVAPCD		SMAQMD
	Category D.2 Refinery Units 20-110 MMBtu/hr	6 ppmv standard 5 ppmv enhanced	9 ppmv
	Category D.3 Refinery Units >110 MMBtu/hr	5 ppmv	9 ppmv
	Category D.4 Refinery Units fired on less than 50% PUC quality gas	9 ppmv	15 ppmv
	Category E Units with annual heat input >1.8 billion Btu/yr but <30 billion Btu/yr	9 ppmv	5-20 MMBtu/hr – 15 ppmv <20 MMBtu/hr – 9 ppmv
	Category F Wastewater Treatment Facilities firing on less than 50% PUC quality gas	9 ppmv	15 ppmv
	Category G Units operated by a small producer in which the rated heat input of each burner is less than or equal to 5 MMBtu/hr but the total rated heat input of all the burners in a unit is rated between 5 MMBtu/hr and 20 MMBtu/hr, and in which the products of combustion do not come in contact with the products of combustion of any other burner.	9 ppmv	15 ppmv

VCAPCD

- VCAPCD Rule 74.15 Boilers, Steam Generators and Process Heaters (5 MMBTUs and greater) *(Amended November 8, 1994)*

The District evaluated the requirements contained within VCAPCD's Rule 74.15 and found no requirements that were more stringent than those already in Rule 4306 and 4320.

	SJVAPCD		VCAPCD
Applicability	Any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input greater than 5 million Btu per hour.		Boilers, steam generators and process heaters, greater than 5 million Btu per hour 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: Burns non-PUC gas no more than 168 cumulative hours in a calendar year plus 48 hours per calendar year for equipment testing; NOx emission do not exceed 150 ppmv.		Electric utility boilers Water Heaters Units fired on alternate fuel during NG curtailment Emergency standby units Cold Startup
Requirements	Category A Units 5-20 MMBtu/hr Except Categories C through G units	9 ppmv standard 6 ppmv enhanced	40 ppmv
	Category B Units > 20 MMBtu/hr Except Categories C through G units	7 ppmv standard 5 ppmv enhanced	40 ppmv
	Category C.1 Oilfield Steam Generators 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	40 ppmv
	Category C.2 Oilfield Steam Generators >20 MMBtu/hr	7 ppmv standard 5 ppmv enhanced	40 ppmv
	Category C.3 Oilfield Steam Generators fired on less than 50% PUC quality gas	9 ppmv	40 ppmv
	Category D.1 Refinery Units 5-20 MMBtu/hr	9 ppmv standard 6 ppmv enhanced	40 ppmv
	Category D.2 Refinery Units 20-110 MMBtu/hr	6 ppmv standard 5 ppmv enhanced	40 ppmv

	Category D.3 Refinery Units >110 MMBtu/hr	5 ppmv	40 ppmv
	Category D.4 Refinery Units fired on less than 50% PUC quality gas	9 ppmv	40 ppmv
	Category E Units with annual heat input >1.8 billion Btu/yr but <30 billion Btu/yr	9 ppmv	1.8 – 9 MMBtu – No NOx Limit 9 – 30 MMBtu – 40 ppmv
	Category F Wastewater Treatment Facilities firing on less than 50% PUC quality gas	9 ppmv	40 ppmv
	Category G Units operated by a small producer in which the rated heat input of each burner is less than or equal to 5 MMBtu/hr but the total rated heat input of all the burners in a unit is rated between 5 MMBtu/hr and 20 MMBtu/hr, and in which the products of combustion do not come in contact with the products of combustion of any other burner.	9 ppmv	40 ppmv

Additional Emission Reduction Opportunities

Over the years, the District has adopted numerous generations of rules and rule amendments for boilers greater than 5 MMBtu/hr that have significantly reduced NOx and PM emissions from this source category. As part of these regulatory efforts, hundreds of boilers in the Valley have been equipped with the best available NOx and PM control technologies. Even though significant effort has already been made to reduce emissions from this source category, the possibility of further reducing emissions from boilers greater than 5 MMBtu/hr is evaluated in the following discussion.

Clearsign Duplex Burners

The Clearsign Duplex burner employs a ceramic material for the fuel to burn on downstream from the actual burner. This reduces the temperature and length of the flame that results in reduced NOx formation without FGR or SCR add-on controls. The Clearsign technology is relatively new and has been installed or under evaluation at two refineries and one oilfield production facility in the Valley. Based on discussion with the facilities evaluating these technologies, additional work is required from the supplier to further improve the reliability and durability of this technology. Preliminary results indicate that this technology has potential to achieve NOx emissions less than 5 ppmv @ 3% O2. The wide spread viability of this technology is still to be determined.

Ultra Low-NOx Burners

Retrofitting 5 to 20 MMBtu/hr units

A boiler, steam generator or process heater in this size range may be retrofitted with ultra-low NOx burner system to achieve 6 ppmv NOx @ 3% O2. Pursuant to a local vendor, the cost of an ultra-low NOx burner with some form of FGR system would be about $40,000. Retrofitting a boiler may involve upgrades to various systems such as fuel train to comply with up to date codes, and may involve upgrades to air intake fans, as these units require more air for the burner to operate at its optimum level.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE)			
Burner System	A	40,000	Local Vendor
Instrumentation and controls	0.01 A	400	OAQPS
Sales Taxes	0.08 A	3,232	
Freight	0.05 A	2,000	OAQPS
Purchased equipment cost, PEC		45,632	
Direct installation costs (DI):			
Foundation & supports	0.08 B	--	See footnote
Handling and erection	0.14 B	6,388	OAQPS
Electrical	0.04 B	1,825	OAQPS
Piping	0.02 B	913	OAQPS
Insulation and ductwork:	0.01 B	456	OAQPS
Painting	0.01 B	456	OAQPS
Direct installation costs		10,038	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC		55,670	
Indirect Costs (Installation)			
Engineering	0.10 B	4,563	OAQPS
Construction and field expenses	0.05 B	2,282	OAQPS
Contractor fees	0.10 B	4,563	OAQPS
Contingencies	0.03 B	1,369	OAQPS
Start-up	0.02 B	913	OAQPS
Performance test	0.01 B	456	OAQPS

Total Indirect Costs, IC	0.31 B	14,146	
Total Capital Investments (TCI= DC + IC):		**69,816**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**11,359**	
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 IAC:			
Total Annual Cost (DAC + IAC)	--	--	
Total annual cost (annualized TCI + Total annual cost)		**$11,359/yr**	

The potential NOx emission reduction for 5 to 20 MMBtu/hr units is determined by taking the difference between the permitted potential emissions and the potential emissions that may be achievable by an ultra-low NOx burner system. Ultra low-NOx burners are expected to achieve 6 ppmv NOx @ 3% O2. Each unit is presumed to be operated for 8,760 hours per year at the maximum rated capacity, unless restricted by annual heat input rate. The total cost for each category is determined by multiplying the number of units and $11,359 a typical annual cost of an ultra-low NOx burner system. Note that most of the units (Category A in Rule 4320 except Category C through G units) are already achieving 9 ppm NOx @ 3% O2 or less emissions.

Type of unit	Number of units	Potential NOx Reductions with ultra-low NOx burner Technology (tons/yr)	Total annualized cost of NOx Reductions with ultra-low NOx burner Technology ($/yr)	Cost effectiveness ($/ton of emission reduction)
Category A: >5.0 MMBtu/hr to ≤ 20 MMBtu/hr, Except Category C through G units	271*	82.7	$3,078,289/yr	**$37,222/ton**

*Total units = 279 – 8 permitted at 6 ppmv NOx or less emissions = 271 units

Retrofitting > 20 MMBtu/hr units

A boiler, steam generator or process heater in this size range may be retrofitted with ultra-low NOx burner to achieve 5 ppmv NOx @ 3% O2. Pursuant to a local vendor, the average cost of an ultra-low NOx burner with some form of FGR system would be about $150,000. Note that retrofitting a boiler may involve upgrades to various systems such as fuel train to comply with up to date codes, and may involve upgrades to air intake fans, as these units require more air for the burner to operate at its optimum level.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE)			
Burner System	A	150,000	Local Vendor
Instrumentation and controls	0.01 A	1,500	OAQPS
Sales Taxes	0.08 A	12,120	
Freight	0.05 A	7,500	OAQPS
Purchased equipment cost, PEC		171,120	
Direct installation costs (DI):			
Foundation & supports	0.08 B	--	See footnote
Handling and erection	0.14 B	23,957	OAQPS
Electrical	0.04 B	6,845	OAQPS
Piping	0.02 B	3,422	OAQPS
Insulation and ductwork:	0.01 B	1,711	OAQPS
Painting	0.01 B	1,711	OAQPS
Direct installation costs		37,646	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC		208,766	
Indirect Costs (Installation)			
Engineering	0.10 B	17,112	OAQPS
Construction and field expenses	0.05 B	8,556	OAQPS
Contractor fees	0.10 B	17,112	OAQPS
Contingencies	0.03 B	5,134	OAQPS
Start-up	0.02 B	3,422	OAQPS
Performance test	0.01 B	1,711	OAQPS
Total Indirect Costs, IC	0.31 B	53,047	
Total Capital Investments (TCI= DC + IC):		**261,813**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**42,597**	
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 IAC:			
Total Annual Cost (DAC + IAC)	--	--	
Total annual cost (annualized TCI + Total annual cost)		**$42,597/yr**	

*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 greater than 20 MMBtu/hr units (Category B in Rule 4320 except Category C through G units) is determined by taking the difference between the permitted potential emissions and the emissions achievable by an ultra-low NOx burner system. Ultra low-NOx burner systems may potentially achieve 5 ppmv NOx @ 3% O2. Each unit is presumed to be operated for 8,760 hours per year at the maximum rated capacity, unless restricted by annual heat input rate. The total cost for each category is determined by multiplying the number of units and $42,597, a typical annual cost of an ultra-low NOx burner system.

Type of unit	Number of units	Potential NOx Reductions with ultra-low NOx burner Technology (tons/yr)	Total annualized cost of NOx Reductions with ultra-low NOx burner Technology ($/yr)	Cost effectiveness ($/ton of emission reduction)
Category B: >20.0 MMBtu/hr except Category C through G units	190*	123.7	$8,093,430/yr	**$65,428/ton**

*Total units = 221 – 31 with 5 ppmv NOx or less emissions = 190 units

<u>Oilfield Steam Generators</u>

A steam generator can be retrofitted with ultra-low NOx burner to achieve 5 ppmv NOx @ 3% O2. Note that retrofitting a steam generator may involve upgrades to various systems such as fuel train to comply with up to date codes, and may involve upgrades to air intake fans, as these units require more air for the burner to operate at it's optimum level. As many steam generators are one off built units, they may have different firebox configurations that may not accept the new burner without varrying degrees of modification. Pursuant to a local facility, the cost of retrofitting a steam generator to a 5 ppmv NOx burner would vary between about $450,000 to $1,800,000 depending on the extent of modifications or upgrades that are needed. Another facility has provided a cost estimate for a new 5 ppmv steam generator of $2,000,000.

Most of the steam generators that would need to be retrofit would be 62.5 MMBtu/hr units. Rule 4306 requires the units to meet 15 ppmv NOx. The cost effectiveness for retrofitting the units from 15 ppm to 5 ppmv is shown below.

{(0.012 lb/MMBtu)(62.5 MMBtu/hr)(8760 hr)(0.80 usage)}/2,000 lb/ton = 2.6 ton NOx

Capital costs $450,000 to $1,800,000 = $72,000 to $288,000 annualized (10 yrs, 10%)

Cost effectiveness = $27,692 to $110,769 per ton reduction

This variability in cost effectiveness is expected as the steam generators in the oilfields are highly variable in size, age, and state of repair.

Enhanced Selective Catalytic Reduction (SCR) Equipment

Facilities may add additional catalyst units onto existing systems and use them in series with the existing catalyst. The feasibility issues with additional catalyst include additional ammonia usage and storage. Ammonia is an extremely hazardous chemical so the additional storage and usage may not be appropriate. Existing units also may not have the footprint required for the additional SCR material needed. Extensive reconfiguration of the facility may be required. New facilities would be able to plan for increased SCR catalyst.

Many existing boilers, steam generators, and process heaters are not equipped with SCR. Installation of SCR on existing equipment may require significant modifications to the equipment be able to install SCR within the appropriate temperature range in the exhaust stream. Additionally, in some instances, the equipment is installed in a setting with other equipment, and there may be challenges regarding the space available to install an SCR catalyst and the requirement ancillary equipment, i.e. ammonia storage and handling equipment. Some boilers greater than 20.0 MMbtu/hr with low NOx burners and SCR were source tested below 5 ppmv NOx to as low as 2 ppmv.

Retrofitting with Selective Catalytic Reduction (SCR) as Potential Control for units between 5-20 MMBtu/hr

SCR technology is predominantly used to reduce NOx emissions from boilers, steam generators and process heaters. Since SCR is post-combustion control, an existing boiler can be retrofitted with this technology. Several units in the Valley are equipped with SCR system. According to information from SCR vendors, the average SCR system cost is $142,500 for the units between 5-20 MMBtu/hr. 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	142,500	SCR vendors
Instrumentation and controls	0.01 A	1,425	OAQPS
Sales Taxes	0.08 A	11,514	
Freight	0.05 A	7,125	OAQPS
Purchased equipment cost, PEC	B = 1.14 A	162,564	
Direct installation costs (DI):			
Foundation & supports	0.08 B	13,005	OAQPS
Handling and erection	0.14 B	22,759	OAQPS
Electrical	0.04 B	6,503	OAQPS
Piping	0.02 B	3,251	OAQPS
Insulation and ductwork:	0.01 B	1,626	OAQPS
Painting	0.01 B	1,626	OAQPS
Direct installation costs	0.30 B	48,770	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC	1.30B + SP+ Bldg.	211,334	
Indirect Costs (Installation)			
Engineering	0.10 B	16,256	OAQPS
Construction and field expenses	0.05 B	8,128	OAQPS

Contractor fees	0.10 B	16,256	OAQPS
Contingencies	0.03 B	4,877	OAQPS
Start-up	0.02 B	3,251	OAQPS
Performance test	0.01 B	1,626	OAQPS
Total Indirect Costs, IC	0.31 B	50,394	
Total Capital Investments (TCI= DC + IC):	**1.61 B + SP + Bldg.**	**261,728**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**$42,583/yr**	

Description of Cost	Cost Factor	Cost	Source
Direct Annual Costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance Costs (labor and material)	0.015 TCI	3,926	OAQPS
Reagent costs (anhydrous ammonia)		--	Not estimated
Electricity Cost:	$0.08848/kWH	--	Not estimated
Catalyst Replacement:	--	--	Catalyst is presumed to last at least over 10 years
	Total DAC:	3,926	
Indirect Annual Costs (IAC)			
Overhead:	--	--	See table footnote
Insurance:	0.01 TCI	2,617	OAQPS
Property Tax:	--	--	See table footnote
Administrative:	--	--	See table footnote
	Total IAC:	2,617	
Total Annual Cost (DAC + IAC)		6,543	
Total annual cost (Annualized TCI + Total annual cost)		**$49,126/yr**	

*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 5 to 20 MMBtu/hr units (Category A in Rule 4320 except Category C through G units) is determined by taking the difference between the permitted potential emissions and the emissions that could be reliably achievable by an SCR system. Source test results of various units with SCR systems indicate that an SCR can potentially achieve 3.5 ppmv NOx @ 3% O2 for units rated between 5 to 20 MMBtu/hr. Each unit is presumed to be operated for 8,760 hours per year at the maximum rated capacity, unless restricted by annual heat input rate. The total cost for this category is determined by multiplying the number of units and $49,126 a typical annual cost of an SCR system for a 5 to 20 MMBtu/hr unit.

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)
Category A: >5.0 MMBtu/hr to ≤ 20 MMBtu/hr, Except Category C through G units	273*	129.0	13,411,398	**$103,964/ton**

*Total units = 279 - 6 units with SCR systems = 273 units

Retrofitting with Selective Catalytic Reduction (SCR) as Potential Control for units greater than 20 MMBtu/hr

SCR technology is predominantly used to reduce NOx emissions from boilers, steam generators and process heaters. Since SCR is post-combustion control, an existing boiler can be retrofitted with this technology. Several units in the Valley are equipped with SCR system. According to information from SCR vendors, the average SCR system cost is $210,000 for units between 20 to 95 MMBtu/hr. 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	210,000	SCR vendors
Instrumentation and controls	0.01 A	2,100	OAQPS
Sales Taxes	0.08 A	16,968	
Freight	0.05 A	10,500	OAQPS
Purchased equipment cost, PEC	B = 1.14 A	239,568	
Direct installation costs (DI):			
Foundation & supports	0.08 B	19,165	OAQPS
Handling and erection	0.14 B	33,540	OAQPS
Electrical	0.04 B	9,583	OAQPS
Piping	0.02 B	4,791	OAQPS
Insulation and ductwork:	0.01 B	2,396	OAQPS
Painting	0.01 B	2,396	OAQPS
Direct installation costs	0.30 B	71,871	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC	1.30B + SP+ Bldg.	311,439	
Indirect Costs (Installation)			
Engineering	0.10 B	23,957	OAQPS
Construction and field expenses	0.05 B	11,978	OAQPS
Contractor fees	0.10 B	23,957	OAQPS
Contingencies	0.03 B	7,187	OAQPS
Start-up	0.02 B	4,791	OAQPS
Performance test	0.01 B	2,396	OAQPS
Total Indirect Costs, IC	0.31 B	74,266	
Total Capital Investments (TCI= DC + IC):	**1.61 B + SP + Bldg.**	**385,705**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**62,754**	

Description of Cost	Cost Factor	Cost	Source
Direct Annual Costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance Costs (labor and material)	0.015 TCI	5,786	OAQPS
Reagent costs (anhydrous ammonia)		--	Not estimated
Electricity Cost:	$0.08848/kWH	--	Not estimated

Catalyst Replacement:	--	--	Catalyst is presumed to last at least over 10 years
Total DAC:		5,786	
Indirect Annual Costs (IAC)			
Overhead:	--	--	See table footnote
Insurance:	0.01 TCI	3,857	OAQPS
Property Tax:	--	--	See table footnote
Administrative:	--	--	See table footnote
Total IAC:		3,857	
Total Annual Cost (DAC + IAC)		9,643	
Total annual cost (Annualized TCI + Total annual cost)		**72,397**	

*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 greater 20 MMBtu/hr units (Category B in Rule 4320 except Category C through G units) is determined by taking the difference between the permitted potential emissions and the emissions that could be reliably achievable by an SCR system. Source test results of various units with SCR system indicate that an SCR can reliably achieve 2.5 ppmv NOx @ 3% O2 (or less) emissions for units greater than 20 MMBtu/hr. Each unit is presumed to be operated for 8,760 hours per year at the maximum rated capacity, unless restricted by annual heat input rate. The total cost for this category is determined by multiplying the number of units and $72,397 a typical annual cost of an SCR system for a 5 to 20 MMBtu/hr unit.

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)
Category B: >20.0 MMBtu/hr, except Category C through G units	190*	123.7	13,755,430	**$41,159/ton**

*Total units = 221 - 31 units with SCR systems = 190 units

Oilfield Steam Generators

The temperature required for SCR to work (600-800 F) is higher than the temperature that of oilfield steam generator exhaust(~250 F). The steam generators would have to be cut open to retrofit SCR into the convection section of the steam generator to operate the SCR system at the correct temperature. This would cause insurmountable heat loss, preventing the production of the steam necessary for the oil field operation. Therefore, oilfield facilities do not use SCR on their steam generators.

Some oilfield steam generators now are being proposed with NOx limits of 5 ppmv with burner controls and without SCR. These units have a ULN burner. Some units already installed and operating with ultra low nox burners combined with flue gas recirculation have demonstrated through source tests to achieve NOx emission levels as low as 3.0 ppmv.

Low Temperature Oxidation

Emerging technologies that may have the potential to reduce emissions were researched. A Low Temperature Oxidation (LTO) System was installed at a dairy in the SCAQMD and was able to reach NOx limits between 1.0 - 3.2 ppmv for loads 4.1 – 13.0 MMBtu/hr. The LTO system utilizes ozone to oxidize and control various pollutants, including NOx. According to the SCAQMD BACT database information, capital and installation costs ranged from $360,000 - $400,000 for the LTO system when it was installed in 1997[20]. Installation within the South Coast region was heavily subsidized with government funding and the installation costs appear cost prohibitive for an installation that is not subsidized. In addition, the LTO system is classified as “Other Technologies” in the SCAQMD BACT guidelines, which means that the technology has not met the achieved in practice (AIP) criteria of six months of continuous operation at a minimum of 50% operating capacity and does not qualify as the lowest achievable emission rate (LAER). Since the technology has not been achieved in practice and is cost prohibitive without significant subsidies, it will not be considered a feasible opportunity at this time.

EMx

The potential for emissions reductions through EMx, the second generation of the SCONOx technology, that is a post-combustion control that reduces NOx, SOx, CO, and volatile organic compound (VOC) emissions, was researched. This technology has not been AIP in the District and there is no available data that indicates that SCONOx or EMx has been installed on boilers even though the manufacturer’s website states that the technology is transferrable to industrial boilers. Based on research of the best available controls from EPA and other air districts, the SCONOx and EMx systems have only been utilized by power plants for control of turbine emissions. In fact, cost effectiveness analyses conducted by the District for the installation of SCONOx/EMx units on large power plant turbine installations within the San Joaquin Valley have been found to not be cost effective. Given the high cost effectiveness demonstrated for turbines and lack of demonstrated practice with boilers, the District does not expect this technology to be feasible or cost effective for reducing emissions from this category.

PM2.5 Limits for Alternative Fuels

The majority of boilers (>5 MMBtu/hr) in the Valley combust Public Utilities Commission (PUC) quality natural gas, which contains a very low sulfur content and inherently has low emissions. Few boilers in the Valley use alternative fuels for their combustion processes. Alternative fuels 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.

Current rule language requires that liquid fuel shall be used only during a PUC-quality natural gas curtailment period provided it contains no more than 15 ppm sulfur. While the use of liquid fuel is strictly limited, the feasibility of reducing PM emissions through

[20] (2012). *SCAQMD Best Available Control Technology (BACT) Database*. Diamond Bar, CA: South Coast Air Quality Management District.

adding PM2.5 limits for units using liquid fuel was explored as part of the District's comprehensive control measure evaluation.

There are 62 units that are allowed to utilize liquid fuel during natural gas curtailments in the Valley (>5 MMBtu/hr) with a combined emissions inventory of approximately 0.02 tons per year of total PM. The low emissions inventory is attributed to the fact that these units utilize liquid fuel as a backup only if there is a natural gas curtailment. In fact, as there have been no recent natural gas curtailments in the Valley, actual emissions from the combustion of liquid fuel is likely zero.

The following three technologies were researched as potential opportunities to reduce PM emissions: baghouses, electrostatic precipitators (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%[21]. However, baghouses are typically not used with liquid-fired boilers due to the potential clogging of the baghouse[22] and are therefore not a recommended technology due to infeasibility and safety issues.

Currently, there are a several produced gas fired steam generators operating in crude oil production facilities that are required by their permits to operate SOx scrubbers and ESPs (to reduce SOx emissions and visible emissions to burning high sulfur produced gas).

As illustrated below, neither PM control technology is a cost effective option for this source category. The cost of the ESP technology does not include costs of retrofitting equipment and/or the facility or compliance monitoring costs, which would drive the cost effectiveness up even more. In addition, the annualized costs provided by EPA for the wet scrubber system are in 2002 dollars, which means the value above would be even greater if it were adjusted to 2018 dollars.

PM Potential Emissions Reductions for 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 control efficiency of an ESP is 99%.
3. The PM control efficiency of a scrubber is 99%.

Potential Emissions Reductions$_{ESP}$ = (Total PM Emissions) x (Control Efficiency)
Potential Emissions Reduction$_{ESP}$ = 0.02 tons/year X 0.99
Potential Emissions Reduction$_{ESP}$ = 0.0198 tons/ year (tpy)

[21] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.*
[22] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.*

Potential Emissions Reductions $_{scrubber}$ = (Total PM Emissions) x (Control Efficiency)
Potential Emissions Reduction $_{scrubber}$ = 0.02 tons/year X 0.99
Potential Emissions Reduction $_{scrubber}$ = 0.0198 tons/ year (tpy)

Annualized Cost of an ESP and Wet Scrubber

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 is \$1,000-\$2,000.[23] 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.[24] The following assumptions in the cost effectiveness calculations:

1. The capital cost of an ESP for a 5 MMBtu/hr boiler is assumed to be \$100,000.
2. The annual maintenance cost of an ESP for a 5 MMBtu/hr boiler is assumed to be \$2,000.
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.

Annual Cost$_{ESP}$ = (Total Capital Cost) x (0.1627) + (Annual Maintenance Cost x 62)
Annual Cost$_{ESP}$ = (\$100,000 x 62) x (0.1627) + (\$2,000 x 62)
Annual Cost$_{ESP}$ = \$1,132,740/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 (62) x (23.85 sm^3/sec)
Annual Cost$_{scrubber}$ = \$79,332,255 year

Cost Effectiveness of an ESP and Wet Scrubber

Cost Effectiveness = Annual Cost / Annual Emissions Reductions

Cost Effectiveness$_{ESP}$ = (\$1,132,740/year) / (0.0198 tons/ year)
Cost Effectiveness$_{ESP}$ = \$57,209,091/ton of PM

[23] 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.
[24] (2002). *Air Pollution Control Technology Fact Sheet: Spray-Chamber/Spray-Tower Wet Scrubber.* Environmental Protection Agency.

Cost Effectiveness$_{scrubber}$ = (\$79,332,255/year) / (0.0198 tons/ year)
Cost Effectiveness$_{scrubber}$ = \$4,006,679,545/ton of PM

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[25], the system was

[25] 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/

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, Aera Energy is currently in collaboration with Glasspoint Solar to consider the potential installation of a large 770-acre solar steam generation system adjacent to an Aera Energy oil production operation in western Kern County. This system would generate 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 relies heavily on solar tax credits, the generation and sale of low carbon fuel standard (LCFS) 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 3 times the current cost. AERA Energy is pursuing this technology to continue its effort in helping lead the industry to cleaner energy. The system proposed would be primarily funded by the solar steam generation equipment manufacturer and outside investors. Aera Energy would commit to purchasing the steam if successfully built.

The project also faces technical challenges, similar to the above pilot projects. Furthermore, the gas-fired steam generators that are required to supplement the system 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. The District is working closely with AERA to facilitate this project.

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.

The District will continue to work with operators of boiler, steam generator, process heater to develop, demonstrate, and deploy new emission control technologies. This includes developing innovative strategies to address challenges like the variable load issue for solar steam generators that may cause individual steam generators to exceed current permitted limits. In such situations, a strategy that allows individual units to potentially operate at a higher level as long as the overall operation of the combined units as a whole results in additional emission reductions.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for emissions from boilers, steam generators, and process heaters. As demonstrated above, Rules 4306 and 4320 currently have in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will work with affected operators to further reduce NOx emissions from boilers, steam generators, and process heaters to the extent that such controls are technologically and economically feasible. Technologies with the potential to further reduce emissions include the latest generation of ultra-low NOx burners, SCR, and ultra-low NOx burners combined with SCR. As demonstrated above, some of these technologies may not be cost-effective or feasible at this time. Therefore, the potential measures include lowering the emission limits for the class and category and lowering the more stringent Advanced Emission Reduction Option (AERO) limit further as follows:

- Boilers and process heaters >5.0 MMBtu/hr to ≤ 20 MMBtu/hr

    - Lower current emissions limitations of 6 ppmv (enhanced) and 9 ppmv (standard) to a new limitation as low as 2.5 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Boilers and process heaters > 20 MMBtu/hr
    - Lower current emissions limitations of 5 ppmv (enhanced) and 7 ppmv (standard) to a new limitation as low as 2 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Oil field steam generators >5.0 MMBtu/hr to ≤ 20 MMBtu/hr
    - Lower current emissions limitations of 6 ppmv (enhanced) and 9 ppmv (standard) to a new limitation as low as 3.5 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Oil field steam generators > 20 MMBtu/hr
    - Lower current emissions limitations of 5 ppmv (enhanced) and 7 ppmv (standard) to a new limitation as low as 2 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Oil field steam generators < 50% PUC quality gas
    - Lower current emissions limitations of 12 ppmv (enhanced initial) and 9 ppmv (enhanced final) to a new limitation as low as 3.5 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Petroleum refinery boilers/process heaters >5.0 MMBtu/hr to ≤ 20 MMBtu/hr
    - Lower current emissions limitations of 9 ppmv to a new limitation as low as 3 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Petroleum refinery boilers/process heaters >20 MMBtu/hr to ≤ 110 MMBtu/hr
    - Lower current emissions limitations of 6 ppmv to a new limitation as low as 3 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Petroleum refinery boilers/process heaters >110 MMBtu/hr
    - Lower current emissions limitations of 5 ppmv to a new limitation as low as 3 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment
- Petroleum refinery boilers/process heaters < 50% PUC quality gas
    - Lower current emissions limitations of 9 ppmv to a new limitation as low as 3 ppmv, with Advanced Emission Reduction Option to allow for advanced technology development and deployment

The above potential measures are projected to provide 0.4 tons NOx per day of additional emissions reductions. The proposed commitments by the District and CARB will each achieve an aggregate emission reduction of direct PM2.5 and NOx. While the commitments include estimates of the emission reductions from each individual measure, final measures as proposed for adoption into the state implementation plan (SIP) may provide more or less emission reductions. The aggregate commitment will guarantee that the total emission reductions will be achieved to attain each NAAQS as expeditiously as practicable.

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C.8 Rule 4307 (Emissions From Boilers Steam Generators And Process Heaters-2.0 MMBtu/Hr To 5.0 MMBtu/Hr)

Discussion

The purpose of Rule 4307 (Boilers, Steam Generators, and Process Heaters – 2.0 MMBtu/hr to 5.0 MMBtu/hr) is to limit emissions of NOx, carbon monoxide (CO), sulfur dioxide (SO2), and particulate matter from units subject to this rule.

Rule 4307 was adopted on December 15, 2005, to establish emissions limits and control requirements for these units which were previously exempt because of their smaller size. Since its adoption, the rule has been amended three times. The October 2008 amendments strengthened the rule by removing some exemptions, imposing NOx limits of 9 or 12 ppmv for new and replacement units, and adding a menu-approach for particulate matter control that also encompasses SOx controls. The rule was amended again in 2011 to specifically incorporate tree nut pasteurizers as a separate type of unit. EPA published a direct final approval of the 2011 amendments to Rule 4307 on February 12, 2015 and deemed this rule as being at least as stringent as established RACT requirements.[26] NOx emissions have been controlled by over 84% for units in this source category.

Emission Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.31	0.30	0.28	0.28	0.27	0.27	0.26	0.26	0.25
NOx	0.45	0.38	0.35	0.34	0.33	0.32	0.31	0.30	0.29
	Winter Average - Tons per day								
PM2.5	0.31	0.29	0.28	0.27	0.27	0.26	0.26	0.25	0.25
NOx	0.44	0.38	0.34	0.33	0.32	0.31	0.30	0.29	0.28

Source Category

This source category includes any gaseous fuel or liquid fuel fired boiler, steam generator, or process heater with a total rated heat input of 2.0 million British thermal units per hour (MMBtu/hr) up to and including 5.0 MMBtu/hr. Based on District data, there are currently 642 active units subject to Rule 4307 requirements[27] permitted with Permits to Operate (PTOs) or Permit-Exempt Equipment Registration (PEER); with the majority of them being PEER units. Facilities with units subject to this rule represent a wide range of industries, including but not limited to, medical facilities, educational institutions, office buildings, prisons, military facilities, hotels, and industrial facilities.

[26] 80 FR 7803-7805
[27] Data based on the permit search conducted on November 17, 2016 and August 23, 2018

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

Federal Regulations
Emissions from this source category are lower than the BACM significance thresholds. The federal Clean Air Act does not require a control measure evaluation for this source category to satisfy BACM requirements. However, the District conducted a full control measure evaluation for this source category to ensure all feasible opportunities to reduce emissions and expedite attainment are pursued.

There are no EPA CTG or NSPS requirements for this source category.

Alternative Control Techniques (ACT)

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

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.

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

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.

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

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.

NESHAP/ MACT

- 40 CFR 63 Subpart DDDDD (NESHAP for Major Sources: Industrial, Commercial, and Institutional Boilers and Process Heaters)

40 CFR 63 Subpart DDDDD was amended on January 31, 2013 to include new emission limits for PM, CO, and total selective metals (TSM), replace numeric dioxin emission limits with work practice standards, add new subcategories of facilities, and add alternative monitoring approaches for compliance with the PM limit. The PM limits in 40 CFR 63 Subpart DDDDD would not apply to Rule 4307 sources. Subpart DDDDD contains alternative requirements for units less than 10 MMBtu/hr and requires tuning every 2-5 years.

The District evaluated the requirements contained within 40 CFR 63 Subpart DDDDD and found no requirements that were more stringent than those already in Rule 4307.

State Regulations
There are no state regulations applicable to this source category.

HOW DOES DISTRICT RULE 4307 COMPARE TO RULES IN OTHER AIR DISTRICTS?

BAAQMD

- BAAQMD Regulation 9, Rule 6 (Nitrogen Oxide Emissions From Natural Gas-Fired Boilers and Water Heaters) *(Amended November 7, 2007)*
  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 4307 and BAAQMD's Regulation 9 Rule 6 and concluded that NOx requirements in SJVAPCD rule are at least equivalent or more stringent than the BAAQMD rule limits for similarly rated units.

- Regulation 9 Rule 7 (Nitrogen Oxides and Carbon Monoxide From Industrial and Commercial Boilers, Steam Generators and Process Heaters) *(Last amended May 4, 2011)*
  BAAQMD Regulation 9 Rule 7 regulates NOx and CO emissions from industrial and commercial boilers, steam generators and process heaters. The District compared the emission limits in District Rule 4307 and BAAQMD's Regulation 9 Rule 7 and concluded that NOx requirements in SJVAPCD rule are at least equivalent or more stringent than the BAAQMD rule limits for similarly rated units.

- Regulation 9, Rule 10 (Nitrogen Oxides and Carbon Monoxide From Boilers, Steam Generators and Process Heaters in Petroleum Refineries) (Last Amended October 16, 2013)
  BAAQMD Regulation 9 Rule 10 regulates NOx and CO emissions from boilers, steam generators and process heaters in petroleum refineries. The District compared the remission limits in District Rule 4307 to the requirements contained within BAAQMD's Regulation 9 Rule 10 and found that NOx requirements in SJVAPCD rule are on an emission-unit by emission-unit basis, whereas, the emission limits in BAAQMD rule is on a refinery-wide basis, and therefore, cannot be compared.

SCAQMD

- Rule 1146.1 (Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters) *(Last amended November 1, 2013)*
  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 1146.1and concluded that NOx requirements in SJVAPCD rule are at least equivalent or more stringent than the SCAQMD rule limits for similarly rated units.

- Rule 1146.2 (Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters) *(Last amended May 5, 2006)*
  SCAQMD Rule 1146.2 regulates NOx and CO emissions from large water heaters and small boilers and process heaters. The District compared the emission limits in District Rule 4307 with SCAQMD Rule 1146.2 and concluded that NOx requirements in SJVAPCD rule are more stringent than the SCAQMD rule limits for 2.0 MMBtu/hr boilers and process heaters.

- Rule 1109 (Emissions of Oxides of Nitrogen from Boilers and Process Heaters in Petroleum Refineries) *(Last amended August 5, 1988)*
  SCAQMD Rule 1146.2 regulates NOx and CO emissions from large water heaters and small boilers and process heaters. The units subject to Rule 4307 would not be subject to requirements of SCAQMD Rule 1109. Therefore, no further analysis is required.

SMAQMD

- Rule 411 (NOx from Boilers, Process Heaters and Steam Generators) *(August 23, 2007)*
  SMAQMD Rule 411 regulates NOx and CO emissions from boilers, process heaters and steam generators. The District compared the emission limits in District Rule 4307 with SMAQMD Rule 411 and concluded that NOx requirements in SJVAPCD rule are at least equivalent or more stringent than the SCAQMD rule limits for similarly rated units.

VCAPCD

- Rule 74.15.1 (Boilers, Steam Generators, and Process Heaters) *(Last amended June 23, 2015)*
  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 NOx requirements in SJVAPCD rule are equivalent to that of the VCAPCD rule limits for similarly rated units.

	SJVAPCD Rule 4307	BAAQMD Reg 9 Rule 6
Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Rule applies to natural gas fired water heaters and boilers, and limits only NOx emissions
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the 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 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• Natural gas-fired boilers and water heaters rated at > 2 MMBtu/hr • Natural gas-fired water heaters used in recreational vehicles. • Water heaters using a fuel other than natural gas. • Natural gas-fired pool/spa heater with <0.4 MMBtu/hr used exclusively to heat swimming pools, hot tubs or spas
Requirements*	**NOx emission limits:** Existing units limited to 1.8 billion Btu/yr • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). 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 NOx (gaseous fuel) New and Replacement units: • 12 ppmv NOx (atmospheric units) • 9 ppmv NOx (non-atmospheric units) **Particulate matter 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% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx emission limits:** Natural gas-fired boilers and water heaters: • 20 ng-NOx/J of heat output or 30 ppm NOx for units >0.4 MMBtu/hr to 2 MMBtu/hr manufactured after Jan 1, 2008 • 14 ng-NOx/J of heat output or 20 ppm NOx for units >0.4 MMBtu/hr to 2 MMBtu/hr manufactured after Jan 1, 2013 **Particulate matter control requirements:** None
Conclusion	NOx requirements in SJVAPCD rule are at least equivalent to or more stringent than the BAAQMD rule for similarly rated units.	

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

	SJVAPCD Rule 4307	BAAQMD Reg 9 Rule 7
Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Rule applies to any industrial, institutional and commercial boilers, steam generator and process.
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the 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 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• Units ≤ 2MMBtu/hr if fired exclusively on natural gas, LPG, or any combination thereof • Units <1MMBtu/hr with any fuel • Units used in petroleum refineries • Boilers used by public electric utilities or qualifying small power production facilities • Waste heat recovery boilers used to recover sensible heat from the exhaust of combustion turbines or reciprocating internal combustion engines • Kilns, ovens, and furnaces used for drying, baking, heat treating, cooking, calcining or vitrifying • Process heater used to heat thermal fluid for radiant comfort heating
Requirements*	**NOx emission limits:** Existing units limited to 1.8 billion Btu/yr • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). 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 NOx (gaseous fuel) New and Replacement units: • 12 ppmv NOx (atmospheric units) • 9 ppmv NOx (non-atmospheric units) **Particulate matter 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% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx and CO emission limits:** Units with <10% of its annual maximum heat capacity in 12 consecutive months: • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit at least once per calendar year, OR • Comply with applicable NOx and CO limits (see below) Units >2 MMBtu/hr to 5 MMBtu/hr: • 30 ppm NOx (gaseous fuels, landfill gas, or digester gas) • 40 ppmv NOx (no-gaseous fuels) • Heat input weighted average limit for NOx (multiple fuels) **Particulate matter control requirements:** None
Conclusion	NOx in SJVAPCD rule are at least equivalent to (e.g., units limited to annual heat input rate) or more stringent (e.g. new and replacement units) than the BAAQMD rule for similarly rated units.	

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

	SJVAPCD Rule 4307	BAAQMD Reg 9 Rule 10
Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Rule applies to boilers, steam generator and process heaters, including CO boilers, in petroleum refineries
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the 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 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• Units < 2MMBtu/hr if fired exclusively on natural gas, LPG, or any combination thereof • Units <1MMBtu/hr with any fuel • Waste heat recovery boilers used to recover sensible heat from the exhaust of combustion turbines or reciprocating internal combustion engines • Waste heat recovery boilers recovering sensible heat from exhaust of combustion turbines or reciprocating IC engines • Units processing H2S process flue gas in sulfur recovery plants and their tail-gas treating units, or sulfuric acid manufacturing plants • Units on non-gaseous fuel when natural gas is unavailable for use • Units including CO boilers that receive ATC subject to BACT for NOx on or after 1/5/1994.
Requirements*	**NOx emission limits:** Existing units limited to 1.8 billion Btu/yr • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). 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 NOx (gaseous fuel) New and Replacement units: • 12 ppmv NOx (atmospheric units) • 9 ppmv NOx (non-atmospheric units) **Particulate matter 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% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx and CO emission limits:** Small unit(<10 MMBtu/hr) requirements: Meet at least one of the following: • Operate in a manner that maintains stack O2≤3% by vol. on dry basis; OR • Tune at least once every 12 months, or within 2 weeks of unit startup if not operated in the last 12 months; OR • Meet applicable limits - 0.033 lb-NOx/MMBtu; 0.2 lb-NOx/MMBtu for CO boilers Refinery-wide* NOx limit: 0.033 lb-NOx/MMBtu of heat input, based on an operating day average Federal refinery-wide NOx limit • 0.20 lb-NOx/MMBtu based on an operating day average (except CO boilers), except during startup, shutdown or curtailed operation Final NOx limit for CO boilers • 150 ppm NOx except during startup and shutdown for non-partial-burn CO boiler, except during startup, shutdown or curtailed operation • 125 ppmv NOx except during startup and shutdown for partial-burn CO boiler, except during startup, shutdown or curtailed operation *Refinery-wide limit is defined as the ratio of the total mass of discharge into the atmosphere of nitrogen oxides, in pounds, to the sum of the actual heat input, in million BTU, calculated over a twenty-four (24) hour operating day. **Particulate matter control requirements:** None
Conclusion	BAAQMD include refinery-wide NOx and CO limits in the rule, whereas SJVAPCD rule include NOx and CO limits on an emission unit basis. Therefore, the NOx cannot be compared.	

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

	SJVAPCD Rule 4307	SCAQMD Rule 1146.1
Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Rule applies to boilers, steam generator and process heaters >2 MMBtu/hr to <5 MMBtu/hr with the exception of RECLAIM facilities (NOx emissions only)
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the 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 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• None
Requirements*	**NOx emission limits:** Existing units limited to 1.8 billion Btu/yr • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, 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 (see below). 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 NOx (gaseous fuel) New and Replacement units: • 12 ppmv NOx (atmospheric units) • 9 ppmv NOx (non-atmospheric units) **Particulate matter 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% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx emission limits:** Existing units (in operation prior to 9/5/08) limited to ≤1.8 billion Btu/yr • Operate and maintain stack O_2 concentrations at 3% by vol. or less for any 15-consecutive-minute averaging period, OR • Tune-in the unit twice per calendar year, OR • Comply with all applicable NOx requirements within 18 months after exceeding the annual limit (see limits below) Existing units in operation prior to 9/8/08 • 30 ppmv NOx or for natural gas-fired units 0.037 lb-NOx/MMBtu New and Replacement units: • 9 ppmv NOx for natural gas fired units • 12 ppmv NOx for natural gas-fired atmospheric units • 15 ppmv NOx for digester gas fired units • 25 ppmv NOx for landfill gas fired units • Weight average limit for multi-fuel units (e.g., units using both natural gas and digester gas, etc.); AND Note: natural gas units installed or modified prior to 9/5/08 complying with 12 ppmv NOx or less may defer compliance until units burner replacement **Particulate matter control requirements:** None
Conclusion	NOx requirements in SJVAPCD rule are equivalent to (e.g., units fired on natural gas fuel) or more stringent (e.g. digester gas or landfill gas NOx limit) than the SCAQMD rule for similarly rated units.	

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

	SJVAPCD Rule 4307	SCAQMD Rule 1146.2
Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Rule applies to natural gas-fired water heaters, boilers, and process heaters rated at ≤2.0 MMBtu/hr
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the 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 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• Units used in recreational vehicles. • Units subject to SCAQMD Rule 1121 (control of nitrogen oxides from residential type, natural gas-fired water heaters) – Rule 1121 applies to units rated at <0.075 MMBtu/hr • The provision of paragraph (c)(3), (c)(4) and (c)(5) shall not apply to: - Any residential unit* - Units with >0.4 & ≤2 MMBtu/hr, demonstrated to use less than 9,000 therms (i.e., 9 billion Btu/yr during every calendar year • Not applicable to units located at RECLAIM facilities Note: *Residential units >1 to ≤2 MMBtu/hr manufactured before 1/1/92 that does not meet 30 ppm NOx and 400 ppm CO; or residential units >1 to ≤2 MMBtu/hr more than 15 years old from date of manufacturing, manufactured on and after 1/1/92, and that does not meet 30 ppm NOx and 400 ppm CO; or residential units >0.4 to ≤1 MMBtu/hr more than 15 years old from data of manufacturing, manufactured on and after 1/1/92, and that does not meet 30 ppm NOx and 400
Requirements*	**NOx emission limits:** <u>Existing units limited to 1.8 billion Btu/yr</u> • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). <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 NOx (gaseous fuel) <u>New and Replacement units</u>: • **12 ppmv NOx (atmospheric units)** • **9 ppmv NOx (non-atmospheric units)** **Particulate matter 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% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx emission limits:** <u>Units >0.4 to ≤2 MMBtu/hr</u>: • **14 ng-NOx/J or 20 ppm NOx (On or after 1/1/2010)** <u>Units >1 to ≤2 MMBtu/hr</u>: • 30 ppmv NOx (on and after 7/1/2002 for units manufactured prior to 1/1/92, requirement is not applicable to units demonstrated to use <9 billion Btu/yr) • 30 ppmv NOx (on and after 1/1/2006 for units more than 15 year old, requirement is not applicable to units demonstrated to use <9 billion Btu/yr) **Particulate matter control requirements:** None
Conclusion	NOx requirements in SJVAPCD rule are more stringent than the SCAQMD rule for 2 MMBtu/hr boilers and process heaters.	

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

	SJVAPCD Rule 4307	SCAQMD Rule 1109

Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Rule applies to boilers and process heater in petroleum refineries
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the 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 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	The requirements shall not apply to: • Boilers or process heater with maximum rated capacity ≤ 40 MMBtu/hr. • Sulfur plant reaction boilers. • Upon approval by the Executive Officer, units which are operated with a total heat input in a 12 month period of less than 10% of the maximum rated capacity for that period.
Requirements*	**NOx emission limits:** Existing units limited to 1.8 billion Btu/yr • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). 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 NOx (gaseous fuel) New and Replacement units: • 12 ppmv NOx (atmospheric units) • 9 ppmv NOx (non-atmospheric units) **Particulate matter 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% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx limit:** 0.03 lb-NOx/MMBtu Note that boilers or process heater with maximum rated capacity ≤ 40 MMBtu/hr would be exempt from the requirements in Rule 1109. **Particulate matter control requirements:** None
Conclusion	The unit subject to Rule 4307 would not be subject to requirements of SCAQMD Rule 1109. Therefore, no further analysis is required.	

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

	SJVAPCD Rule 4307	SMAQMD Rule 411
Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Applicable to boilers, steam generators, and process heaters fired on gaseous or non-gaseous fuels with a rated capacity ≥1 MMBtu/hr
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the 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 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• Electric utility boilers • Process heater, kilns and furnaces, where products of combustion come in direct contact with the material to be heated. • Waste heat recovery boilers. • Low fuel usage exemption (e.g., 40,000 therms/yr for 1 to <2.5 MMBtu/hr) • Standing pilot flame burners (heat input 5 MMBtu/hr or less and NOx emissions 30 ppmv or less).
Requirements*	**NOx emission limits:** Existing units limited to 1.8 billion Btu/yr • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). 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 NOx (gaseous fuel) New and Replacement units: • 12 ppmv NOx (atmospheric units) • 9 ppmv NOx (non-atmospheric units) **Particulate matter 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% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx emission limits** ***Gaseous fuels:*** Units ≥1 to <5 MMBtu/hr: • 30 ppm NOx (gaseous fuel) Units ≥ 5 to ≤ 20 MMBtu/hr: • 15 ppm NOx Gas fired reformer furnaces • 30 ppm NOx Units ≥5 MMBtu/hr fired on landfill gas or combination of landfill and natural gas: • 15 ppm NOx Load following units ≥5 MMBtu/hr • 15 ppm NOx ***Non-gaseous fuels:*** Units ≥1 MMBtu/hr • 40 ppmv NOx
Conclusion	NOx requirements in SJVAPCD rule are equivalent to or more stringent than the SMAQMD rule for similarly rated units.	

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

	SJVAPCD Rule 4307	VCAPCD Rule 74.15.1
Applicability	Rule applies to any gaseous fuel or liquid fuel fired boilers, steam generators and process heaters rated ≥2.0 MMBtu/hr to ≤5.0 MMBtu/hr	Rule applies to any gaseous fuel or liquid fuel fired boiler, steam generator, or process heaters with a rated heat input capacity ≥1 MMBtu/hr and <5 MMBtu/hr
Exemptions	• Solid fuel fired units • Dryers and glass melting furnaces • Kilns, humidifiers, and smelters where the products of combustion come into direct contact with the material to be heated • Unfired or fired waste heat recovery boilers that are used to recover or augment heat from the 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 hour/year plus 48 hour/year for equipment testing and NOx emissions shall not exceed 150 ppmv or 0.215 lb/MMBtu	• The requirements shall not apply when a unit is operated on alternative fuel during natural gas curtailment period. Alternative fuel use shall not exceed the period of natural gas curtailment. Alternative fuel use is required to maintain the alternate fuel system, and in this case use shall not exceed 50 hours/year. • Portable oil well dewaxing process heater is not subject to 30 ppmv NOx, if annual heat input rate is less than 2.8 billion Btu.
Requirements*	**NOx emission limits:** Existing units limited to 1.8 billion Btu/yr • Install & maintain non-resettable fuel flow meter; AND • Tune-in the unit twice per calendar year, OR • Operate and maintain the stack O_2 concentrations at 3% by vol. or less, OR • Certify unit to comply with 30 ppmv NOx (gaseous fuel) when annual limit is exceeded; if unit is replaced then comply with limits of New and Replacement units (see below). 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 NOx (gaseous fuel) New and Replacement units: • 12 ppmv NOx (atmospheric units) • 9 ppmv NOx (non-atmospheric units) **Particulate matter 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% O_2; AND • Liquid fuel shall be used only during a PUC quality natural gas curtailment period provided the fuel does not contain 15 ppm sulfur	**NOx emission limits** Units with heat input rate ≥1.8 billion Btu/yr: • 30 ppm NOx, Units ≥ 1 to ≤ 2 MMBtu/hr: • 20 ppm NOx, (natural gas-fired) Units > 2 to < 5 MMBtu/hr: • 12 ppm NOx (natural gas, atmospheric) • 9 ppm NOx (natural gas, pressurized) • 25 ppm NOx (landfill gas) • 15 ppm NOx (biogas) • 20 ppm NOx (LPG) • 15 ppm NOx (Produced oilfield gas, atmospheric) • 12 ppm NOx (Produced oilfield gas, pressurized) 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 in no case less than once per calendar year; OR • The unit shall comply with the emission and testing requirements **Particulate matter control requirements:** None
Conclusion	NOx requirements in SJVAPCD rule are equivalent to VCAPCD rule for similarly rated units.	

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

Additional Emission Reduction Opportunities

The District has adopted numerous rule amendments over the years for boilers that have significantly reduced emissions from units subject to Rule 4307. Most units subject to Rule 4307 are fired on Public Utilities Commission (PUC) quality natural gas, and are inherently low-emitters of SOx and PM2.5 emissions. The following potential control techniques are evaluated to achieve further reductions:

Retrofitting with Selective Catalytic Reduction (SCR) as Potential Control
SCR technology is predominantly used to reduce NOx emissions from boilers, steam generators and process heaters. Since SCR is post-combustion control, an existing boiler can be retrofitted with this technology. In fact, two small boilers (each rated at 4.98 MMBtu/hr) in the Valley were equipped with SCR system. According to information from one of the facilities, the SCR system cost was $97,500 for the 4.98 MMBtu/hr boiler. 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	97,500	District facility
Instrumentation and controls	0.01 A	975	OAQPS
Sales Taxes	0.08 A	7,878	
Freight	0.05 A	4,875	OAQPS
Purchased equipment cost, PEC	B = 1.14 A	111,228	
Direct installation costs (DI):			
Foundation & supports	0.08 B	8,898	OAQPS
Handling and erection	0.14 B	15,572	OAQPS
Electrical	0.04 B	4,449	OAQPS
Piping	0.02 B	2,225	OAQPS
Insulation and ductwork:	0.01 B	1,112	OAQPS
Painting	0.01 B	1,112	OAQPS
Direct installation costs	0.30 B	33,368	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC	1.30B + SP+ Bldg.	144,596	
Indirect Costs (Installation)			
Engineering	0.10 B	11,123	OAQPS
Construction and field expenses	0.05 B	5,561	OAQPS
Contractor fees	0.10 B	11,123	OAQPS
Contingencies	0.03 B	3,337	OAQPS
Start-up	0.02 B	2,225	OAQPS
Performance test	0.01 B	1,112	OAQPS
Total Indirect Costs, IC	0.31 B	34,481	
Total Capital Investments (TCI= DC + IC):	**1.61 B + SP + Bldg.**	**179,077**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**29,136**	

Description of Cost	Cost Factor	Cost	Source
Direct Annual Costs (DAC)			
Operating and supervisory labor	--	--	See table footnote
Maintenance Costs (labor and material)	0.015 TCI	2,686	OAQPS
Reagent costs (anhydrous ammonia)		--	Not estimated
Electricity Cost:	$0.08848/kWH	--	Not estimated
Catalyst Replacement:	--	--	Catalyst is presumed to last at least over 10 years
	Total DAC:	2,686	
Indirect Annual Costs (IAC)			
Overhead:	--	--	See table footnote
Insurance:	0.01 TCI	1,791	OAQPS
Property Tax:	--	--	See table footnote
Administrative:	--	--	See table footnote
	Total IAC:	1,791	
Total Annual Cost (DAC + IAC)		4,477	
Total annual cost (Annualized TCI + Total annual cost)		**33,613**	

*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. 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 $33,613 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 unit (atmospheric), 12 ppm NOx	18	2.1	605,034	**$292,924/ton**
New and replacement units (non atmospheric), 9 ppmv NOx	116	10	3,899,108	**$377,823/ton**
Existing units (gaseous fuel), 30 ppmv NOx	273	115.1	9,176,349	**$79,725/ton**
Existing units (gaseous fuel), Low-use, ≤1.8 billion Btu/yr	214	18.5	7,193,182	**$389,568/ton**
Existing units – Liquid fuel	2*	--	--	**--**
Existing units - Liquid fuel ≤5 billion Btu/yr	3**	--	--	**--**
Miscellaneous others, various NOx levels (15-27.2 ppmv NOx)	16	4.8	537,808	**$112,807/ton**

*Units are mounted on a nitrogen delivery trucks and are operated intermittently to vaporize nitrogen gas. **Three PEERs were identified originally (two PEERs were cancelled, one is in dormant is dormant non operation status). The cost-effectiveness analysis is not performed for these units.

Retrofit with Ultra low-NOx burner

A boiler, steam generator or process heater can be retrofitted with ultra-low NOx burner to reliably achieve 9 ppmv NOx @ 3% O2. Pursuant to a local vendor, the cost of an ultra-low NOx burner would be about $40,000. However, it is important to note that retrofitting an existing boiler may not always be feasible and if feasible, boiler may involve upgrades to various systems such as fuel train to comply with up to date 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 can add considerable costs to the retrofit, which are not included below.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE)			
Burner System	A	40,000	Local Vendor
Instrumentation and controls	0.01 A	300	OAQPS
Sales Taxes	0.08 A	2,424	
Freight	0.05 A	1,500	OAQPS
Purchased equipment cost, PEC		34,224	
Direct installation costs (DI):			
Foundation & supports	0.08 B	--	See footnote
Handling and erection	0.14 B	4,791	OAQPS
Electrical	0.04 B	1,369	OAQPS
Piping	0.02 B	684	OAQPS
Insulation and ductwork:	0.01 B	342	OAQPS
Painting	0.01 B	342	OAQPS
Direct installation costs		7,528	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC		51,752	
Indirect Costs (Installation)			
Engineering	0.10 B	3,422	OAQPS
Construction and field expenses	0.05 B	1,711	OAQPS
Contractor fees	0.10 B	3,422	OAQPS
Contingencies	0.03 B	1,027	OAQPS
Start-up	0.02 B	684	OAQPS
Performance test	0.01 B	342	OAQPS
Total Indirect Costs, IC	0.31 B	10,608	
Total Capital Investments (TCI= DC + IC):		**62,360**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**10,146**	
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 IAC:			
Total Annual Cost (DAC + IAC)	--	--	
Total annual cost (annualized TCI + Total annual cost)		**10,146**	

*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 an ultra-low NOx burner system. Ultra low-NOx burner 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 $8,519 a typical annual cost of an ultra-low NOx burner system.

Type of unit	Number of units	Potential NOx Reductions with ultra-low NOx burner Technology (tons/yr)	Total annualized cost of NOx Reductions with SCR Technology ($/yr)	Cost effectiveness ($/ton of emission reduction)
New and replacement unit (atmospheric), 12 ppm NOx	18	0.9	153,342	**$172,585/ton**
New and replacement units (non atmospheric), 9 ppmv NOx	116	Not needed, units are already equipped with 9 ppmv burner		
Existing units (gaseous fuel), 30 ppmv NOx	273	97.1	2,769,858	**$28,525/ton**
Existing units (gaseous fuel), Low-use, ≤1.8 billion Btu/yr	214	17.5	1,823,066	**$104,000/ton**
Existing units – Liquid fuel	2*	See Footnote below		
Existing units - Liquid fuel ≤5 billion Btu/yr	3**	See Footnote below		
Miscellaneous others, various NOx levels (15-27.2 ppmv NOx)	16	3.3	136,304	**$40,822/ton**

*Units are mounted on a nitrogen delivery truck and are operated intermittently to vaporize nitrogen gas. **Three PEERs were identified originally (two PEERs were cancelled, one is in dormant is dormant non operation status). The cost-effectiveness analysis is not performed for these units.

Replacing an older unit

Replacement of an older boiler in many cases may be the only way to reduce NOx emissions. The new units can reliably achieve 9 ppmv NOx @ 3% O2. The cost of these units depend on the heat input rate, use of unit (steam, hot water, etc.), control system, heat recovery systems (economizer etc.). Per local vendor, cost of a steam boiler rated at 5.0 MMBtu/hr (300 psi) with gas train, control system and economizer would be $122,000. Note that 94% of the unit are greater than 2.0 MMBtu/hr; therefore, it is reasonable to use this cost data for cost effectiveness analysis.

Description of Cost	Cost Factor	Cost	Source
Direct Costs			
Purchase equipment costs (PE)			
Burner System	A	122,000	Local Vendor
Instrumentation and controls	--	--	Included in the above price
Sales Taxes	0.08 A	9,760	
Freight	0.05 A	6,100	OAQPS
Purchased equipment cost, PEC		137,860	
Direct installation costs (DI):			
Foundation & supports	0.08 B	11,029	See footnote
Handling and erection	0.14 B	19,300	OAQPS
Electrical	0.04 B	5,514	OAQPS
Piping	0.02 B	2,757	OAQPS
Insulation and ductwork:	0.01 B	1,379	OAQPS
Painting	0.01 B	1,379	OAQPS
Direct installation costs		41,358	
Site preparation	As required, SP	--	See table footnote
Buildings	As required, Bldg.	--	
Total Direct Costs, DC		179,218	
Indirect Costs (Installation)			
Engineering	0.10 B	13,786	OAQPS
Construction and field expenses	0.05 B	6,893	OAQPS
Contractor fees	0.10 B	13,786	OAQPS
Contingencies	0.03 B	4,136	OAQPS
Start-up	0.02 B	2,757	OAQPS
Performance test	0.01 B	1,379	OAQPS
Total Indirect Costs, IC	0.31 B	42,737	
Total Capital Investments (TCI= DC + IC):		**221,955**	
Annualized TCI (10 years @ 10% interest)	0.1627 TCI	**36,112**	
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 IAC:			
Total Annual Cost (DAC + IAC)	--	--	
Total annual cost (annualized TCI + Total annual cost)		**36,112**	

*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 ultra-low NOx burner system. Ultra low-NOx burner 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 $36,112 a typical annual cost of a unit with an ultra-low NOx burner system.

Type of unit	Number of units	Potential NOx Reductions with new unit equipped with ultra-low NOx burner Technology (tons/yr)	Total annualized cost of NOx Reductions with new unit equipped with ultra-low NOx burner Technology ($/yr)	Cost effectiveness ($/ton of emission reduction)
New and replacement unit (atmospheric), 12 ppm NOx	18	0.9	650,034	**$731,588/ton**
New and replacement units (non atmospheric), 9 ppmv NOx	116	Not needed, units are already equipped with 9 ppmv burner		
Existing units (gaseous fuel), 30 ppmv NOx	273	125.1	9,858,576	**78,776/ton**
Existing units (gaseous fuel), Low-use, ≤1.8 billion Btu/yr	214	17.5	7,727,968	**$440,855/ton**
Existing units – Liquid fuel	2*	--	--	**--**
Existing units - Liquid fuel ≤5 billion Btu/yr	3**	--	--	**--**
Miscellaneous others, various NOx levels (15-27.2 ppmv NOx)	16	3.3	577,792	**$175,088/ton**

*Units are mounted on a nitrogen delivery truck and are operated intermittently to vaporize nitrogen gas. **Three PEERs were identified originally (two PEERs were cancelled, one is in dormant is dormant non operation status). The cost-effectiveness analysis is not performed for these units.

EMx as Potential Control

The District researched post-combustion controls such as EMx, the second generation of the SCONOx technology that reduces NOx, SOx, CO, and volatile organic compound (VOC) emissions. Per EmeraChem, manufacturer/vendor of the technology, this technology has not been achieved in practice (AIP) for natural gas fired boilers. SCONOx and EMx systems have only been utilized by power plants for the control of turbine emissions. The cost of 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, EMx system is ideal for new installation, and become extremely challenging and sometimes nearly impossible to retrofit 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.

PM2.5 Limits for Alternative Fuels

The majority of boilers (2-5 MMBtu/hr) in the Valley combust PUC-quality natural gas; PUC 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. Alternative fuels 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. Current rule language requires that on and after July 1, 2015 liquid fuel shall be used only during a PUC quality natural gas curtailment period provided it contains no more than 15 ppm sulfur. While the currently limited use of liquid fuel became even more strictly limited, the feasibility of reducing PM emissions through adding PM2.5 limits for units using liquid fuel is explored as part of the District's comprehensive control measure evaluation.

There are 19 permitted units in the Valley (2-5 MMBtu/hr) that are capable to burn diesel fuel; 17 of the 19 units were installed at healthcare and correctional facilities, 2 units were installed on a nitrogen gas delivery trucks. The units at healthcare and correctional facilities are primarily operated on natural gas, but they're required to have diesel as backup fuel, in case there is interruption in natural gas supply. The total potential emissions from these units while operating on diesel fuel are 0.233 tons/year (0.000061 tons per day) of total PM.

The following three technologies were evaluated as potential control options for reducing PM emissions: baghouses, electrostatic precipitators (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%.[28] However, baghouses are typically not used with liquid-fired boilers due to the potential clogging of the baghouse and are therefore not a recommended technology due to infeasibility and safety issues.[29]

<u>PM Potential Emissions Reductions for an ESP and Scrubber</u>

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.

[28] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fwww.nescaum.org%2Fdocuments%2Fici-boilers-20081118-final.pdf%2F&ei=7nfvVIivFai1sAT07IHIAg&usg=AFQjCNFBdQn7MVAibSTZIbHV7-ojXkVlXQ&bvm=bv.86956481,d.cWc.

[29] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fwww.nescaum.org%2Fdocuments%2Fici-boilers-20081118-final.pdf%2F&ei=7nfvVIivFai1sAT07IHIAg&usg=AFQjCNFBdQn7MVAibSTZIbHV7-ojXkVlXQ&bvm=bv.86956481,d.cWc.

2. The PM control efficiency of an ESP is 99%.
3. The PM control efficiency of a scrubber is 99%.

Potential Emissions Reductions $_{(ESP)}$ = (Total PM Emissions) x (Control Efficiency)
Potential Emissions Reductions $_{(ESP)}$ = 0.233 tons/year x 0.99
Potential Emissions Reductions $_{(ESP)}$ = 0.231 tons/ year (tpy)

Potential Emissions Reductions $_{(scrubber)}$ = (Total PM Emissions) x (Control Efficiency)
Potential Emissions Reductions $_{(scrubber)}$ = 0. 233 tons/year x 0.99
Potential Emissions Reductions $_{(scrubber)}$ = 0.231 tons/ year (tpy)

<u>Annualized Cost of an ESP and Wet Scrubber</u>
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 is \$1,000-\$2,000.[30] 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.[31] The following assumptions were made for this cost effectiveness analysis:

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

Annual Cost $_{(ESP)}$ = (Total Capital Cost) x (0.1627) + (Annual Maintenance Cost)
Annual Cost $_{(ESP)}$ = (\$95,000 x 19) x (0.1627) + (\$1,500 x 19)
Annual Cost $_{(ESP)}$ = \$322,174/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 (19) x (23.85 sm^3/sec)
Annual Cost $_{(scrubber)}$ = \$24,311,498/ year

[30] 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.
[31] EPA. (2002). *Air Pollution Control Technology Fact Sheet: Spray-Chamber/Spray-Tower Wet Scrubber.* Retrieved from http://www.epa.gov/ttncatc1/dir1/fsprytwr.pdf.

Cost Effectiveness of an ESP and Wet Scrubber

Cost Effectiveness = Annual Cost / Annual Emissions Reductions

Cost Effectiveness $_{(ESP)}$ = ($322,174/year) / (0.231 tons/ year)
Cost Effectiveness $_{(ESP)}$ = $1,394,693/ton of PM

Cost Effectiveness $_{(scrubber)}$ = ($24,311,498/year) / (0.231 tons/ year)
Cost Effectiveness $_{(scrubber)}$ = $105,244,580/ton of PM

As illustrated above, neither PM control technology is a cost effective option for this source category. The cost of the ESP technology does not include costs of retrofitting equipment and/or the facility or compliance monitoring costs, which would drive the cost effectiveness up even more.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for Boilers, Steam Generators, and Process Heaters in the 2.0 MMBtu/hr to 5.0 MMBtu/hr size range. As demonstrated above, Rule 4307 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

C.9 Rule 4308 (Emissions from Small Boilers, Steam Generators, and Process Heaters- 0.075 MMBtu/hr to less than 2.0 MMBtu/hr)

Discussion

The purpose of this rule is to limit oxides of nitrogen (NOx) and carbon monoxide (CO) emissions from units within this source category. As a point of sale rule, Rule 4308 achieves emissions reductions as units subject to the rule are replaced 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.

Rule 4308 was adopted on October 20, 2005 to establish NOx emissions limits for these units which 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. In 2013, the rule was amended to lower the NOx emission limit for instantaneous water heaters 0.075 MMBtu/hr to 0.4 MMBtu/hr to 20 ppmv. EPA published a direct final approval the 2013 amendments to Rule 4308 on February 12, 2015.[32]

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.59	0.56	0.53	0.52	0.52	0.50	0.49	0.48	0.47
NOx	0.86	0.73	0.67	0.64	0.62	0.58	0.56	0.54	0.52
	Winter Average - Tons per day								
PM2.5	0.58	0.55	0.53	0.52	0.51	0.49	0.48	0.47	0.47
NOx	0.84	0.71	0.65	0.63	0.61	0.57	0.55	0.53	0.51

Source Category

This source category includes any person who supplies, sells, offers for sale, installs, or solicits the installation of any boiler, steam generator, process heater or water heater with a rated heat input capacity greater than or equal to 0.075 MMBtu/hr and less than 2.0 MMBtu/hr. Units subject to Rule 4308 (Boilers, Steam Generators and Process Heaters – 0.75 MMBtu/hr to less than 2.0 MMBtu/hr) are used in a wide variety of settings including, but not limited to, apartment buildings, large homes, small businesses, commercial buildings, manufacturing facilities, government facilities, restaurants, hotels, hospitals, educational institutions, and religious organizations. Affected persons include water heater manufacturers, plumbing wholesalers, supply stores, plumbers, contractors, and end-users.

[32] 80 FR 7803-7805

HOW DOES DISTRICT RULE 4308 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There are no EPA CTG, NSPS, NESHAP, or MACT requirements for boilers, steam generators, and process heaters of such small size.

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 covered by District Rule 4308 have the potential to emit 25 tons per year and therefor ACTs are not directly applicable to this source category. However, ACTs do discuss various control technologies, and so the District has examined them, as follows:

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

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

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

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.

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

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?

South Coast AQMD

- SCAQMD Rule 1146.2 Emissions of Oxides of Nitrogen From Large Water Heaters and Small Boilers and Process Heaters *(Last Amended May 5, 2006)*

SCAQMD Rule 1146.2 regulates NOx emissions from large water heaters and small boilers and process heaters. The District compared the emission limits in District Rule 4308 with SCAQMD Rule 1146.2 (see Table 4) and concluded that NOx limits in the

SJVAPCD rule are equivalent to the NOx limits in the SCAQMD rule for similarly rated units.

<table>
<tr><th></th><th>SJVAPCD Rule 4308</th><th>SCAQMD 1146.2</th></tr>
<tr><td>Applicability</td><td>Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr</td><td>Applicable to <u>natural gas-fired</u> water heaters, boilers and process heaters with rated heat input capacity of ≤2 MMBtu/hr</td></tr>
<tr><td>Exemptions</td><td>Units installed in manufactured homes.
Units installed in recreational vehicles.
Hot water pressure washers.</td><td>Units used in recreational vehicles.
Units subject to SCAQMD Rule 1121 (control of nitrogen oxides from residential type, natural gas-fired water heaters) – Rule 1121 applies to units rated at <0.075 MMBtu/hr
The provision of paragraph (c)(3), (c)(4) and (c)(5) shall not apply to:
- Any residential unit*
- Units with >0.4 & ≤2 MMBtu/hr, demonstrated to use less than 9,000 therms during every calendar year
Not applicable to units located at RECLAIM facilities
Note:
*Residential units >1 to ≤2 MMBtu/hr manufactured before 1/1/92 that does not meet 30 ppm NOx and; or residential units >1 to ≤2 MMBtu/hr more than 15 years old from date of manufacturing, manufactured on and after 1/1/92, and that does not meet 30 ppm NOx and 400 ppm CO; or residential units >0.4 to ≤1 MMBtu/hr more than 15 years old from data of manufacturing, manufactured on and after 1/1/92, and that does not meet 30 ppm NOx.</td></tr>
<tr><td>Requirements*</td><td><u>Units ≥0.075 to ≤0.4 MMBtu/hr (except, instantaneous water heater and pool heaters below)</u>:
PUC gas - 20 ppmv NOx (0.024 lb/MMBtu);
Non-PUC or liquid – 77 ppmv NOx (0.093 lb/MMBtu)
<u>Units >0.4 to <2.0 MMBtu/hr (except, instantaneous water heater and pool heaters below)</u>:
PUC gas – 20 ppmv NOx (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 <2.0 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)
<u>Pool heaters >0.4 to <2.0 MMBtu/hr</u>:
PUC gas – 20 ppmv (0.068 lb/MMBtu)
Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)</td><td><u>Units ≥0.4 to ≤2 MMBtu/hr</u>:
14 ng-NOx/J of heat output or 20 ppmv NOx (or less)
<u>Units (excluding pool heaters) ≤0.4 MMBtu/hr</u>:
14 ng-NOx/J of heat output or 20 ppmv NOx (or less)</td></tr>
</table>

Bay Area AQMD

- BAAQMD Regulation 9, Rule 6 Nitrogen Oxide Emissions From Natural Gas-Fired Boilers and Water Heaters *(Last Amended November 7, 2007)*

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 (see Table 1) and concluded that NOx emission limits in SJVAPCD rule are equivalent to the BAAQMD rule limits for similarly rated units.

	SJVAPCD Rule 4308	BAAQMD Reg 9 Rule 6
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Rule applies to natural gas fired water heaters and boilers, and limits only NOx emissions
Exemptions	• Units installed in manufactured homes. • Units installed in recreational vehicles. • Hot water pressure washers.	• Natural gas-fired boilers and water heaters rated at > 2 MMBtu/hr • Natural gas-fired water heaters used in recreational vehicles. • Water heaters using a fuel other than natural gas. • Natural gas-fired pool/spa heater with <0.4 MMBtu/hr used exclusively to heat swimming pools, hot tubs or spas
Requirements*	1. 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) 2. Units >0.4 to <2.0 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) 3. 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) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. 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) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	Natural gas-fired storage tank water heaters ≤0.075 MMBtu/hr: • 40 ng-NOx/J of heat output for units manufactured after July 1, 1992 • 10 ng-NOx/J* of heat output for 50 gal or less units manufactured after Jan 1, 2009; • 10 ng-NOx/J* of heat output for > 50 gal units manufactured after Jan 1, 2010; • 10 ng-NOx/J** of heat output for units manufactured after Jan 1, 2011; Notes: *The limit shall not apply to direct-vent, power-vent, power direct-vent water storage tanks heater and water heaters used for mobile homes. **This limit dos not apply to water heater used for mobile homes. Natural gas-fired boilers and water heaters >0.075 MMBtu/hr to ≤2 MMBtu/hr: • 40 ng-NOx/J of heat output for units >0.075 MMBtu/hr to 0.4 MMBtu/hr manufactured after Jan 1, 2008 • 14 ng-NOx/J of heat output for units >0.075 MMBtu/hr to 0.4 MMBtu/hr manufactured after Jan 1, 2013 • 20 ng-NOx/J of heat output or 30 ppm NOx for units >0.4 MMBtu/hr to 2 MMBtu/hr manufactured after Jan 1, 2008 • 14 ng-NOx/J of heat output or 20 ppm NOx for units >0.4 MMBtu/hr to 2 MMBtu/hr manufactured after Jan 1, 2013 Natural gas-fired mobile home water heaters: • 40 ng-NOx/J of heat output for units manufactured after Jan 1, 2008 Natural gas-fired pool/spa heaters: • 40 ng-NOx/J of heat output or 55 ppmv for units >0.4 MMBtu/hr to 2.0 MMBtu/hr manufactured after Jan 1, 2008 • 14 ng-NOx/J of heat output or 20 ppmv for units >0.4 MMBtu/hr to 2.0 MMBtu/hr manufactured after Jan 1, 2013

- BAAQMD Regulation 9, Rule 7 Nitrogen Oxides and Carbon Monoxide From Industrial, Institutional and Commercial Boilers, Steam Generators and Process Heaters *(Last Amended May 4, 2011)*

BAAQMD Regulation 9 Rule 7 regulates NOx and CO emissions from industrial and commercial boilers, steam generators and process heaters. The District compared the emission limits in District Rule 4308 and BAAQMD's Regulation 9 Rule 7 (see Table 2) and concluded NOx emission limits in SJVAPCD rule are equivalent to the BAAQMD rule limits for similarly rated units.

	SJVAPCD Rule 4308	BAAQMD Reg 9 Rule 7
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Rule applies to any industrial, institutional and commercial boilers, steam generator and process.
Exemptions	• Units installed in manufactured homes. • Units installed in recreational vehicles. • Hot water pressure washers.	• Units ≤ 2MMBtu/hr if fired exclusively on natural gas, LPG, or any combination thereof • Units <1MMBtu/hr with any fuel • Units used in petroleum refineries • Boilers used by public electric utilities or qualifying small power production facilities • Waste heat recovery boilers used to recover sensible heat from the exhaust of combustion turbines or reciprocating internal combustion engines • Kilns, ovens, and furnaces used for drying, baking, heat treating, cooking, calcining or vitrifying • Process heater used to heat thermal fluid for radiant comfort heating

	SJVAPCD Rule 4308	BAAQMD Reg 9 Rule 7
Requirements*	1. 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) 2. Units >0.4 to <2.0 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) 3. 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) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. 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) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	Landfill or digester gas fired units ≥1 MMBtu/hr: • 30 ppm NOx Non-gaseous fuel fired units ≥1 MMBtu/hr: • 40 ppm NOx Multiple fuel fired units ≥1 MMBtu/hr: • Heat input weighted average limit for NOx Note that requirements for units with heat input rate > 2 MMBtu/hr are not listed, as these requirements are irrelevant for the purpose of Rule 4308, which applies to units with heat input rate of ≥0.075 MMBtu/hr and <2 MMBtu/hr

- BAAQMD Regulation 9, Rule 10 Nitrogen Oxides and Carbon Monoxide From Boilers, Steam Generators and Process Heaters in Petroleum Refineries *(Last Amended October 16, 2013)*

BAAQMD Regulation 9 Rule 10 regulates NOx and CO emissions from boilers, steam generators and process heaters in petroleum refineries. The District compared the remission limits in District Rule 4308 to the requirements contained within BAAQMD's Regulation 9 Rule 10 (see Table 3) and found that NOx requirements in SJVAPCD rule are on an emission-unit by emission-unit basis, whereas the emission limits in BAAQMD rule is on a refinery-wide basis, and therefore cannot be compared.

	SJVAPCD Rule 4308	BAAQMD Reg 9 Rule 10
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Rule applies to boilers, steam generator and process heaters, in petroleum refineries
Exemptions	• Units installed in manufactured homes. • Units installed in recreational vehicles. • Hot water pressure washers.	• Units < 2MMBtu/hr if fired exclusively on natural gas, LPG, or any combination thereof • Units <1MMBtu/hr with any fuel • Waste heat recovery boilers used to recover sensible heat from the exhaust of combustion turbines or reciprocating internal combustion engines

		• Waste heat recovery boilers recovering sensible heat from exhaust of combustion turbines or reciprocating IC engines • Units processing H2S process flue gas in sulfur recovery plants and their tail-gas treating units, or sulfuric acid manufacturing plants • Units on non-gaseous fuel when natural gas is unavailable for use • Units including CO boilers that receive ATC subject to BACT for NOx on or after 1/5/1994.
Requirements*	1. 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) 2. Units >0.4 to <2.0 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) 3. 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) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. 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) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	Small unit(<10 MMBtu/hr) requirements: Meet at least one of the following: • Operate in a manner that maintains stack O2≤3% by vol. on dry basis; OR • Tune at least once every 12 months, or within 2 weeks of unit startup if not operated in the last 12 months; OR • Meet applicable limits - 0.033 lb-NOx/MMBtu; 0.2 lb-NOx/MMBtu for CO boilers Refinery-wide* NOx limit: 0.033 lb-NOx/MMBtu of heat input, based on an operating day average Federal refinery-wide NOx limit • 0.20 lb-NOx/MMBtu based on an operating day average (except CO boilers), except during startup, shutdown or curtailed operation Final NOx limit for CO boilers • 150 ppm NOx except during startup and shutdown for non-partial-burn CO boiler • 125 ppmv NOx except during startup and shutdown for partial-burn CO boiler *Refinery-wide limit is defined as the ratio of the total mass of discharge into the atmosphere of nitrogen oxides, in pounds, to the sum of the actual heat input, in million BTU, calculated over a twenty-four (24) hour operating day.

Sac Metro AQMD

- SMAQMD Rule 411 NOx From Boilers, Process Heaters, and Steam Generators *(Last Amended August 23, 2007)*

SMAQMD Rule 411 regulates NOx and CO emissions from boilers, process heaters and steam generators. The District compared the emission limits in District Rule 4308 with SMAQMD Rule 411 (see Table 5) and concluded that NOx emission limits in SJVAPCD rule are more stringent than the NOx limits in SMAQMD rule for similar rated units.

	SJVAPCD Rule 4308	SMAQMD Rule 411
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Applicable to 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.	• Electric utility boilers • Process heater, kilns and furnaces, where products of combustion come in direct contact with the material to be heated. • Waste heat recovery boilers. • Low fuel usage exemption (e.g., 40,000 therms/yr for 1 to <2.5 MMBtu/hr) • Standing pilot flame burners (heat input 5 MMBtu/hr or less and NOx emissions 30 ppmv or less).
Requirements*	1. 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) 2. Units >0.4 to <2.0 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) 3. 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) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. 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) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	**Gaseous fuels:** Units ≥1 to <5 MMBtu/hr: • 30 ppm NOx **Non-gaseous fuels:** Units ≥1 MMBtu/hr • 40 ppmv NOx

- SMAQMD Rule 414 Water Heaters, Boilers and Process Heaters Rated Less than 1 MMBtu/hr *(Last Amended March 25, 2010)*

SMAQMD Rule 414 regulates NOx and CO emissions from boilers, process heaters and steam generators. The District compared the emission limits in District Rule 4308 with SMAQMD Rule 414 (see Table 6) and concluded that for gaseous fuels, NOx emission limits in SJVAPCD rule are equivalent to the NOx limits in SMAQMD rule for similar rated units.

	SJVAPCD Rule 4308	SMAQMD Rule 414
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Applicable to boilers, steam generators, and process heaters fired on gaseous or non-gaseous fuels with a rated capacity of <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 heater with a heat input rate <0.075 MMBtu/hr. • Water heaters, boilers and process heater fired on LPG fuel.
Requirements*	1. 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) 2. Units >0.4 to <2.0 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) 3. 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) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. 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) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	Units <0.075 MMBtu/hr: • 40 ng/J of heat output or 55 ppm NOx for mobile home units • 10 ng/J of heat output or 15 ppm NOx for all other units Units ≥ 0.075 to <0.4 MMBtu/hr: • 40 ng/J of heat output or 55 ppm NOx for pool/spa units • 14 ng/J of heat output or 20 ppm NOx for all other units Units ≥ 0.4 to <1 MMBtu/hr: • 14 ng/J of heat output or 20 ppm NOx

Ventura County APCD

- VCAPCD Rule 74.11.1 – Large Water Heaters and Small Boilers *(Last Amended September 11, 2012)*

VCAPCD Rule 74.11.1 regulates NOx and CO emissions from boilers, steam generators, and process heaters. The District compared the emission limits in District Rule 4308 with VCAPCD (see Table 7) and concluded that NOx emission limits in SJVAPCD rule are equivalent to the NOx limits in VCAPCD rule for similar rated units.

	SJVAPCD Rule 4308	VCAPCD Rule 74.11.1
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Applicable to natural gas-fired water heater, boiler, steam generator or process heater with a rated heat input capacity ≥0.075 BTU/hr and < 1 MMBtu/hr

	SJVAPCD Rule 4308	VCAPCD Rule 74.11.1
Exemptions	• Units installed in manufactured homes. • Units installed in recreational vehicles. • Hot water pressure washers.	• None
Requirements*	1. 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) 2. Units >0.4 to <2.0 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) 3. 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) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. 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) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	Units ≥ 0.075 to ≤0.4 MMBtu/hr: • 40 ng/J of heat output (93 lb/billion Btu), or 55 ppm NOx for units designed to heat swimming pools, hot tubs or spas. • 14 ng/J of heat output or 20 ppm NOx for all other units Units > 0.4 to <1 MMBtu/hr: • 14 ng/J of heat output or 20 ppm NOx for all units

- VCAPCD Rule 74.15.1 – Boilers, Steam Generators, and Process Heaters *(Last Amended June 23, 2015)*

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 4308 with VCAPCD (see Table 8) and concluded that the NOx emission limits in SJVAPCD rule are equivalent to the NOx limits in VCAPCD rule for similar rated units.

	SJVAPCD Rule 4308	VCAPCD Rule 74.15.1
Applicability	Applicable to boilers, steam generators and process heaters with rated heat input capacity of ≥0.075 MMBtu/hr and <2 MMBtu/hr	Rule applies to any gaseous fuel or liquid fuel fired boiler, steam generator, or process heaters 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.	• The requirements shall not apply when a unit is operated on alternative fuel during natural gas curtailment period. Alternative fuel use shall not exceed the period of natural gas curtailment. Alternative fuel use is required to maintain the alternate fuel system, and in this case use shall not exceed 50 hours/year.

	SJVAPCD Rule 4308	VCAPCD Rule 74.15.1
		• Portable oil well dewaxing process heater is not subject to 30 ppmv NOx, if annual heat input rate is less than 2.8 billion Btu.
Requirements*	1. 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) 2. Units >0.4 to <2.0 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) 3. 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) 4. Instantaneous water heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.024 lb/MMBtu) • Non-PUC or liquid – 77 ppmv (0.093 lb/MMBtu) 5. 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) 6. Pool heaters >0.4 to <2.0 MMBtu/hr: • PUC gas – 20 ppmv (0.068 lb/MMBtu) • Non-PUC or liquid – 30 ppmv (0.036 lb/MMBtu)	Units with heat input rate ≥1.8 billion Btu/yr: • 30 ppm NOx Units ≥ 1 to ≤ 2 MMBtu/hr: • 20 ppm NOx (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 in no case less than once per calendar year; OR • The unit shall comply with the emission and testing requirements

Additional Emission Reduction Opportunities

Use of a Selective Catalytic Reduction system

SCR is a post combustion technology. 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[33].

Assuming an SCR system reliably reduces NOx emissions from 20 ppmv @ 3% O_2 to 5 ppmv @ 3% O_2 for a 1.99 MMBtu/hr unit that operates 8,760 hours per year, the potential reductions would be 310 lb/year[34] (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.

[33] See Rule 4307 draft control measure analysis. Note that there is no significant price difference for an SCR system on 2-5 MMBtu/hr unit or smaller units.
[34] 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 ultra-low NOx burner technology
Ultra low NOx burners can reliably achieve at least 9 ppmv NOx @ 3% O_2 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 an ultra-low NOx burner system. Per local vendor, cost of a 2 MMBtu/hr boiler would be $35,000 for 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

Description of Cost	Cost Factor	Cost	Source
Total IAC:			
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 an ultra-low NOx burner system reliably reduces NOx emissions from 20 ppmv @ 3% O_2 to 9 ppmv @ 3% O_2 for a 1.99 MMBtu/hr unit that operates 8,760 hours per year, the potential reductions would be 227 lb/year[35] (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.

EMx as Potential Control

The District researched post-combustion controls such as EMx, the second generation of the SCONOx technology that reduces NOx, SOx, CO, and volatile organic compound (VOC) emissions. Per EmeraChem, manufacturer/vendor of the technology, this technology has not been achieved in practice (AIP) for natural gas fired boilers. SCONOx and EMx systems have only been utilized by power plants for the control of turbine emissions. The cost of 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, and become extremely challenging and sometimes nearly impossible to retrofit 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 Limits for Alternative Fuels

The majority of units 0.075 to less than 2 MMBtu/hr in the Valley combust PUC-quality natural gas; PUC 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. Alternative fuels 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 feasibility of reducing PM emissions through adding PM2.5 limits for units using liquid fuel is explored as part of the District's comprehensive control measure evaluation.

The following three technologies were evaluated as potential control options for reducing PM emissions: baghouses, electrostatic precipitators (ESPs), and wet scrubbers. Baghouses control total PM and PM2.5 emissions by 90-99%; ESPs control

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

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%.[36] However, baghouses are typically not used with liquid-fired boilers due to the potential clogging of the baghouse and are therefore not a recommended technology due to infeasibility and safety issues.[37] 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.

PM Potential Emissions Reductions for an ESP and Scrubber

For the purposes of these calculations, the following assumptions were made:

4. For simplicity, the analysis will evaluate the cost effectiveness of these technologies for total PM reductions from liquid fuel fired units.
5. 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.
6. Max rating of burner = 1.99 MMBtu/hr and assumed to operate 8,760 hours/yr.
7. The PM control efficiency of an ESP is 99%.
8. The PM control efficiency of a scrubber is 99%.
9. Due to lack of units in the Valley, the analysis is based on one known unit.

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 (tpy)

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

Annualized Cost of an ESP and Wet Scrubber

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[36] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fwww.nescaum.org%2Fdocuments%2Fici-boilers-20081118-final.pdf%2F&ei=7nfvVIivFai1sAT07IHIAg&usg=AFQjCNFBdQn7MVAibSTZIbHV7-ojXkVlXQ&bvm=bv.86956481,d.cWc.

[37] Northeast States for Coordinated Air Use Management. (November 2008) *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Retrieved from http://www.google.com/url?sa=t&rct=j&q=&esrc=s&source=web&cd=1&cad=rja&uact=8&ved=0CB8QFjAA&url=http%3A%2F%2Fwww.nescaum.org%2Fdocuments%2Fici-boilers-20081118-final.pdf%2F&ei=7nfvVIivFai1sAT07IHIAg&usg=AFQjCNFBdQn7MVAibSTZIbHV7-ojXkVlXQ&bvm=bv.86956481,d.cWc.

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 is \$1,000-\$2,000.[38] 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.[39] The following assumptions were made for this cost effectiveness analysis:

8. The capital cost of an ESP is assumed to be the median of the range above (\$95,000).
9. The annual maintenance cost of an ESP is assumed to be the median of the range above (\$1,500).
10. The annualized cost of a wet scrubber system is assumed to be the median of the range above (\$53,650 per sm^3/sec).
11. 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).
12. 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.
13. 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.
14. 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.

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 of an ESP and Wet Scrubber</u>

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

[38] 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.
[39] EPA. (2002). *Air Pollution Control Technology Fact Sheet: Spray-Chamber/Spray-Tower Wet Scrubber.* Retrieved from http://www.epa.gov/ttncatc1/dir1/fsprytwr.pdf.

As illustrated above, neither PM control technology is a cost effective option for this source category. The cost of the ESP technology does not include costs of retrofitting equipment and/or the facility or compliance monitoring costs, which would increase the cost even more.

Mobile Home Exemption
The District evaluated the possibility of removing the exemption for water heaters used in mobile homes because multiple air districts do not exempt these sources in their analogous rules. However, because those air districts have different rule structures with regards to the size of devices regulated, District Rule 4308 requirements are as stringent as the other districts' rules.

For example, SCAQMD Rule 1146.2 does not regulate mobile home water heaters, per the definition for type 1 units, because they are subject to Rule 1121 (Control of Nitrogen Oxides from Residential Type, Natural Gas-Fired Water Heaters). SCAQMD Rule 1121 regulates units less than 0.075 MMBtu/hr, which is out of the size range of District Rule 4308. Similarly, in SMAQMD Rule 414, mobile home units are regulated in the size range of units less than 0.075 MMBtu/hr. District Rule 4902 (Residential Water Heaters) applies to units less than 0.075 MMBtu/hr and currently regulates mobile home water heaters with the same emission limit contained in SCAQMD and SMAQMD rules. BAAQMD Rule Regulation 9 Rule 6 regulates all units less than 2 MMBtu/hr, essentially combining the requirements of District Rules 4308 and 4902.

In addition, after researching the size of mobile home water heaters, it was found that mobile home water heaters are not available in the 0.075-2.0 MMBtu/hr size range. Four mobile home retailers and three mobile home manufacturers were contacted to inquire about the size of mobile home water heaters. All seven contacts stated that the average size of a mobile home water heater is 30-40 gallons, whereas a 0.075 MMBtu/hr water heater is approximately 80 gallons. One manufacturer and one retailer stated that 50 gallon mobile home water heaters are available but rarely used. If the exemption for mobile home water heaters in Rule 4308 were to be removed, it would not result in any additional emissions reductions since such units are not available and do not exist in this size range.

Recreational Vehicle Exemption
The District evaluated the potential opportunity to remove the exemption for recreational vehicles (RVs). Stakeholder input indicates that there are very few units in RVs that fall under the size category subject to this rule. Most units in RVs are 12 gallons, which is significantly smaller than the 80 gallon size of a typical 0.075 MMBtu/hr unit.[40] Also, RV units are typically not used on a frequent basis and thus are small contributors to the NOx emissions of this source category. Other air districts, such as SCAQMD and BAAQMD, include this exemption in their rules. Removing this exemption would result in little to no emissions reductions because of the lack of units within this size range and the intermittent use of units in RVs.

[40] SJVAPCD. (2009). *Final Staff Report for Amendments to Rule 4308 (Boilers, Steam Generators, and Process Heaters—0.075 MMBtu/hr to less than 2.0 MMBtu/hr)*.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for the small boilers addressed by this rule. As demonstrated above, Rule 4308 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

C.10 Rule 4309 (Emissions from Dryers, Dehydrators, and Ovens)

Discussion

Rule 4309 (Dryers, Dehydrators, and Ovens) was adopted on December 15, 2005 to limit nitrogen oxides (NOx) and carbon monoxide (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. The rule limits NOx emissions to between 3.5-12 ppmvd for four categories of equipment. The adoption of Rule 4309 has considerably reduced NOx and PM emissions from this source category, reducing the emissions inventory for NOx from dryers, dehydrators, and ovens from 1.93 tpd in 2005 to 0.22 tpd in 2016. Although this source category had a relatively small emissions inventory prior to the adoption of Rule 4309, stakeholders have installed control equipment and modified their operations considerably to reduce emissions to ultra-low levels. Given the significant effort and technology investments already made to reduce emissions from this source category, there are little remaining opportunities for obtaining additional emissions reductions.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.87	0.95	1.02	1.04	1.06	1.09	1.11	1.13	1.15
NOx	0.20	0.22	0.24	0.25	0.25	0.26	0.26	0.27	0.27
	Winter Average - Tons per day								
PM2.5	0.82	0.89	0.96	0.98	0.99	1.03	1.05	1.07	1.09
NOx	0.18	0.20	0.21	0.22	0.22	0.23	0.23	0.24	0.24

Source Category

This source category includes 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 5.0 million British thermal units per hour (MMBtu/hr) or greater. There are currently 120 units subject to this rule, ranging in size from 5.0 MMBtu/hr to 200 MMBtu/hr. Dryers, dehydrators, and ovens are utilized in a broad range of industries and can be grouped as: dehydrators; asphalt and concrete plants; milk, cheese, and dairy processing; and other processes. Dryers, dehydrators, and ovens are operated either seasonally or year-round depending on the industry type and the unit's purpose within the process.

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

Federal Regulations

There are no EPA CTG, NSPS, NESHAP, or MACT requirements applicable for this source category.

Alternative Control Techniques (ACT)

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

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?
There are no analogous rules for this source category in the BAAQMD

SCAQMD

- South Coast AQMD Rule 1147 (NOx Reductions from Miscellaneous Sources) *(last amended July 7, 2017)*

SCAQMD Rule 1147 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 liquid fueled units, high temperature applications, evaporators, fryers, etc. In other categories, the NOx limits under the SCAQMD 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 SCAQMD Rule 1147.

	SJVAPCD Rule 4309 (12/15/2005)	SCAQMD Rule 1147 (7/7/2017)
Applicability	Rule applies to 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 5.0 MMBtu/hr or greater.	Rule applies to manufacturers, distributors, retailers, installers, owners, and operators of ovens, dryers, dehydrators, heaters, kilns, calciners, furnaces, crematories, incinerators, heated pots, cookers, roasters, fryers, closed and open heated tanks and evaporators, distillation units, afterburners, degassing units, vapor incinerators, catalytic or thermal oxidizers, soil and water remediation units and other combustion equipment with nitrogen oxide emissions that require a District permit and are not specifically required to comply with a nitrogen oxide emission limit by other District Regulation XI rules. This rule does not apply to solid fuel-fired combustion equipment, internal combustion engines, turbines, food ovens, charbroilers, boilers, water heaters, thermal fluid heaters, enclosed process heaters and other combustion equipment subject to nitrogen oxide limits of other District Regulation XI rules.
Exemptions		
Rule 4309 Exemption Categories:	Sections of the Rule	
Column-type or tower dryers used to dry grains, or tree nuts.	Section 4.1.1	No such exemptions stated in the rule.

	SJVAPCD Rule 4309 (12/15/2005)	SCAQMD Rule 1147 (7/7/2017)			
Units to pre-condition onions or garlic prior to dehydration	Section 4.1.2				
Smokehouses or units used for roasting	Section 4.1.3				
Units used to dry lint cotton or cotton at cotton gins	Section 4.1.6				
Units to bake or fry food for human consumption	Section 4.1.4	SC Rule 1147 Exempts existing fryers installed and operated within specified dates as stated in Section (g)(6). New fryers installed after January 1, 2014 are subject to Table 1 emission limit of 60 ppmvd @3% O2 (or 6.5 ppmvd @ 19% O2). In-use food ovens, including ovens, dryers, smokers, and dry roasters, are exempt from Rule 1147 but subject to Rule 1153.1 with the following limits: Units operating ≤ 500° F, 40 ppmvd, (4.3 ppmvd @ 19% O2), or 0.042 lb/MMBtu Units operating > 500° F, 60 ppmvd, (6.5 ppmvd @ 19% O2), or 0.073 lb/MMBtu			
Charbroilers	Section 4.1.5 – Exempt from rule	Section (g)(2) - Exempt from rule			
Requirements					
Rule 4309 Equipment Categories:					
Gaseous Fuel-Fired Equipment	No process temperature	**Process Temperature**			
			≤ 800° F	> 800° F and < 1200°F	≥ 1200 ° F
Dehydrators	-	Oven, Dehydrator, Dryer, Heater, Kiln, Calciner, Cooker, Roaster, Furnace, or Heated Storage Tank	30 ppmvd (3.3 ppmvd @ 19% O2) or 0.036 lb/MMBtu (not specific to dehydrators)		60 ppmvd (6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu (not specific to dehydrators)
Asphalt/Concrete Plants	4.3 ppmvd @ 19 %O2	Asphalt Manufacturing Operation	40 ppmvd (4.3 ppmvd @ 19% O2)		No requirement
Milk, Cheese and Dairy Processing (<20 MMBtu/hr)	3.5 ppmvd @ 19% O2 (equates to 0.04 lb/MMBtu)	No such category			
Milk, Cheese and Dairy Processing (≥20 MMBtu/hr)	5.3 ppmvd @ 19% O2 (equates to 0.061 lb/MMBtu)				
Other processes not described above	4.3 ppmvd @ 19% O2 (equates to 0.049 lb/MMBtu)	Afterburner, Degassing Unit, Remediation Unit, Thermal Oxidizer, Catalytic Oxidizer or Vapor Incinerator[1]	60 ppmvd (6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu		
		Burn-off Furnace, Burnout Oven, Incinerator or Crematory with or without Integrated Afterburner			
		Evaporator, Fryer, Heated Process Tank, or Parts Washer	60 ppmvd (6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu		No requirement

	SJVAPCD Rule 4309 (12/15/2005)	SCAQMD Rule 1147 (7/7/2017)		
		Metal Heat Treating, Metal Melting Furnace, Metal Pot, or Tar Pot	60 ppmvd (6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu	
		Oven, Dehydrator, Dryer, Heater, Kiln, Crematory, Incinerator, Calciner, Cooker, Roaster, Furnace, or Heated Storage Tank	30 ppmvd (3.3 ppmvd @ 19% O2) or 0.036 lb/MMBtu	60 ppmvd (6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu
		Make-Up Air Heater or other Air Heater located outside of building with temperature controlled zone inside building	30 ppmvd (3.3 ppmvd @ 19% O2) or 0.036 lb/MMBtu	No requirement
		Tenter Frame or Fabric or Carpet Dryer	30 ppmvd (3.3 ppmvd @ 19% O2) or 0.036 lb/MMBtu	No requirement
		Other Unit or Process Temperature	30 ppmvd (3.3 ppmvd @ 19% O2) or 0.036 lb/MMBtu	60 ppmvd (6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu
Liquid Fuel-Fired Equipment		≤ 800° F	>800° F and <1200° F	≥ 1200 ° F
All liquid fuel-fired Units	Varies from 3.5 ppmvd @ 19% O2 to 12 ppmvd @ 19% O2	40 ppmvd (4.3 ppmvd @ 19% O2) or 0.053 lb/MMBtu		60 ppmvd (6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu

[1] Emission limit applies to burners in units fueled by 100% natural gas that are used to incinerate air toxics, VOCs, or other vapors; or to heat a unit. The emission limit applies solely when burning 100% fuel and not when the burner is incinerating air toxics, VOCs, or other vapors. The unit shall be tested or certified to meet the emission limit while fueled with natural gas.

SMAQMD

- SMAQMD Rule 419 (NOx from Miscellaneous Combustion Units) *(Adopted July 26, 2018)*

SMAQMD Rule 419 only applies to miscellaneous combustion units located at Major Stationary Sources of NOx. Currently the District has 30 permitted dehydrators, with 60% of these units (18 units) located at non major source of NOx that would not be subject to SM Rule 419. For other units subject to District rule 4309, there are 90 permitted units with 70 located at non-Major Sources of NOx that would not be subject to SM Rule 419.

For units located at major sources of NOx, SM 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.

In conclusion, the vast the majority of the permitted units in the San Joaquin Valley subject to District rule 4309 are located at non-Major Sources of NOx would be exempt from NOx limits under SM Rule 419. Units located at Major Sources of NOx in the Valley are subject to District Rule 4309 NOx limits which are equivalent to those NOx limits under SM rule 419. Therefore, overall, District Rule 4309 is as stringent as SMAQMD Rule 419.

	SJVAPCD Rule 4309 (12/15/2005)	SMAQMD Rule 419 (7/26/2018)	
Applicability	Rule applies to 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 5.0 MMBtu/hr or greater.	This rule applies to any miscellaneous combustion unit with a total rated heat input capacity of 2 million Btu per hour or greater located at a major stationary source of NOx.	
Exemptions			
Rule 4309 Exemption Categories:	**Sections of the Rule**		
Column-type or tower dryers used to dry grains, or tree nuts.	Section 4.1.1	No such exemption stated in the rule.	
Units to pre-condition onions or garlic prior to dehydration	Section 4.1.2		
Charbroilers	Section 4.1.5		
Units used to dry lint cotton or cotton at cotton gins	Section 4.1.6		
Smokehouses or units used for roasting	Section 4.1.3	Smokehouses are not listed among exempt categories. Whereas, rule exempts roasters.	
Units to bake or fry food for human consumption	Section 4.1.4	Section 114.4 exempts cooking units which are used for food preparation for human consumption.	
Requirements			
Rule 4309 Equipment Categories:			
	No process temperature	Process Temperature	
Gaseous Fuel-Fired Equipment		< 1200° F	≥ 1200° F
Dehydrators	-	For units located at a major stationary source of NOx 30 ppmvd (equates to 3.3 ppmvd @ 19% O2) or 0.036 lb/MMBtu	For units located at a major stationary source of NOx 60 ppmvd (equates to 6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu
Asphalt/Concrete Plants	4.3 ppmvd @ 19% O2 (equates to 0.0492 lb/MMBtu)		
Milk, Cheese and Dairy Processing (<20 MMBtu/hr)	3.5 ppmvd @ 19% O2 (equates to 0.04 lb/MMBtu)		
Milk, Cheese and Dairy Processing (≥20 MMBtu/hr)	5.3 ppmvd @ 19% O2 (equates to 0.061 lb/MMBtu)		
Other processes not described above	4.3 ppmvd @ 19% O2 equates to 0.0492 lb/MMBtu		
Liquid Fuel-Fired Equipment			
All liquid fuel-fired Units	Varies from 3.5 ppmvd @ 19% O2 to 12 ppmvd @ 19% O2	For units located at a major stationary source of NOx 40 ppmvd (equates to 4.3 ppmvd @ 19% O2) or 0.053 lb/MMBtu	For units located at a major stationary source of NOx 60 ppmvd (equates to 6.5 ppmvd @ 19% O2) or 0.073 lb/MMBtu

VCAPCD

- VCAPCD Rule 74.34 (NOx Reductions from Miscellaneous Sources) (Adopted December 13, 2016)

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 VCAPCD Rule 74.34.

<table>
<tr><th></th><th>SJVAPCD Rule 4309 (12/15/2005)</th><th colspan="2">VCAPCD Rule 74.34 (12/13/2016)</th></tr>
<tr><td>Applicability</td><td>Rule applies to 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 5.0 MMBtu/hr or greater.</td><td colspan="2">This rule applies to 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 million BTU per hour or greater.</td></tr>
<tr><td>Exemptions</td><td></td><td colspan="2"></td></tr>
<tr><td>Rule 4309 Exemption Categories:</td><td>Sections of the Rule</td><td colspan="2"></td></tr>
<tr><td>Column-type or tower dryers used to dry grains, or tree nuts.</td><td>Section 4.1.1</td><td colspan="2" rowspan="6">No such exemption stated in the rule.</td></tr>
<tr><td>Units to pre-condition onions or garlic prior to dehydration</td><td>Section 4.1.2</td></tr>
<tr><td>Smokehouses or units used for roasting</td><td>Section 4.1.3</td></tr>
<tr><td>Units to bake or fry food for human consumption</td><td>Section 4.1.4</td></tr>
<tr><td>Charbroilers</td><td>Section 4.1.5</td></tr>
<tr><td>Units used to dry lint cotton or cotton at cotton gins</td><td>Section 4.1.6</td></tr>
<tr><td>Requirements</td><td></td><td colspan="2"></td></tr>
<tr><td>Rule 4309 Equipment Categories:</td><td></td><td colspan="2"></td></tr>
<tr><td>Dehydrators</td><td>-</td><td colspan="2">Dehydrators are not subject to this rule as they are not listed under applicability of the rule.</td></tr>
<tr><td>Asphalt/Concrete Plants</td><td>4.3 ppmvd @ 19% O2 (equates to 0.0492 lb/MMBtu)</td><td colspan="2">40 ppmvd (equates to 4.3 ppmvd @ 19% O2) or 0.048 lb/MMBtu</td></tr>
<tr><td>Milk, Cheese and Dairy Processing (<20 MMBtu/hr)</td><td>3.5 ppmvd @ 19% O2 (equates to 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 ppmvd @ 19% O2 (equates to 0.061 lb/MMBtu)</td></tr>
<tr><td rowspan="2">Other processes not described above</td><td rowspan="2">4.3 ppmvd @ 19% O2 equates to 0.0492 lb/MMBtu</td><td>Sand and Gravel Processing (dryers)</td><td rowspan="2">40 ppmvd (equates to 4.3 ppmvd @ 19% O2) or 0.048 lb/MMBtu</td></tr>
<tr><td>Paper Products Manufacturing (Hot Air Furnace, Duct Burner, Paper Dryer)</td></tr>
</table>

		Metal Heat Treatment/Metal Melting Furnace	60 ppmvd (equates to 6.5 ppmvd @ 19% O_2) or 0.072 lb/MMBtu	
		Kiln	80 ppmvd (equates to 8.7 ppmvd @ 19% O_2) or 0.096 lb/MMBtu	
			Process Temperature	
			< 1200° F	≥ 1200° F
		Oven, Dryer (besides asphalt, sand or paper dryer), Heater, Incinerator, Other Furnaces, or Other Duct Burner (Not listed above in Table 1)	30 ppmvd (equates to 3.3 ppmvd @ 19% O_2) or 0.036 lb/MMBtu	60 ppmvd (equates to 6.5 ppmvd @ 19% O_2) or 0.072 lb/MMBtu

Additional Emission Reduction Opportunities

Asphalt Plants

PUC-quality natural gas fuel is the lowest emitting fuel for asphalt plants, and is generally required for new facilities in the District, BAAQMD, and SCAQMD, where natural gas is available. There are currently ten asphalt plants in the Valley that do not utilize PUC-quality natural gas because these facilities are physically too far removed from natural gas lines to use natural gas. Eight of these asphalt plants use LPG fuel or propane to comply with the same gaseous fuel fired limit as PUC-quality natural gas-fired facilities. The other two facilities utilize fuel oil #2; however, none of the facilities operate full time and their combined actual NOx emissions are 0.006 tons per day, an insignificant contributor to the inventory.

Dehydrators

Dehydrators in the Valley are used to process a very large variety of products such as onions, garlic, tomatoes, various fruits and vegetable. There are very specific operational and technical limitations associated with dehydrator operations depending on the type of product processed. More specifically, the District has determined that requiring low-NOx burners is not feasible for vegetable dehydration operations due to product quality issues. For instance, low NOx burners inherently emit higher CO which causes dried garlic and onion to turn pink, negatively affecting product quality/value. The District will continue to evaluate the feasibility and cost-effectiveness of low-NOx burners for potential additional emission reduction opportunities.

Evaluation Findings

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for dryers, dehydrators, and ovens. As demonstrated above, Rule 4309 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM and MSM requirements for this source category.

C.11 Rule 4311 (Emissions from Flares)

Discussion

Rule 4311 was adopted in June 2002 to reduce VOC, NOx, and SOx emissions from operations involving the use of flares. Amendments were adopted on June 15, 2006 and June 18, 2009. The June 2009 amendment incorporated requirements for flare minimization plans and increased the stringency of existing requirements for sulfur emissions. In addition to Rule 4311 requirements, any new flare is subject to New Source Review (NSR) requirements (District Rule 2201) including Best Available Control Technology (BACT) requirements which would require implementation of even more stringent controls regardless of Rule 4311 requirements when applicable.

In 2017, flaring activities in the Valley emitted 0.57 tpd of NOx emissions and 0.16 tpd of PM2.5, representing 0.27% of the winter average NOx emissions and 0.28% of the winter average PM2.5 emissions in the Valley. Despite this relatively small amount of emissions, in keeping with its leave-no-stone-unturned approach, the District has invested significant resources into evaluating potential emissions reductions opportunities from flares.

The District committed to continue evaluating flares through a further study measure in the District's *2012 PM2.5 Plan* and *2013 Plan for the Revoked 1-Hour Ozone Standard*. The District completed and published the *Rule 4311 (Flares) Further Study* report on September 16, 2014 (*2014 Study*).[41] In that study, District staff reviewed the submitted Flare Minimization Plans, Annual Monitoring Report data, Reportable Flaring Event data, and new NSPS requirements to identify and evaluate potential opportunities to further reduce emissions from flaring. In addition to the review committed in the plans, the District also reviewed the flare emission inventory in the Valley and analogous rules in other air districts in California. In the *2014 Study*, the District concluded that operators of flares in the Valley were subject to the most stringent emission requirements and were proactively implementing alternatives and committing to activities that reduce flaring. Based on that conclusion, the District recommended no rulemaking action for Rule 4311 at that time.

On April 16, 2015, the District's Governing Board adopted the *2015 Plan for the 1997 PM2.5 Standard* (*2015 PM2.5 Plan*)[42]. As demonstrated in the District's *2015 PM2.5 Plan*, Rule 4311 already meets the Environmental Protection Agency's (EPA) Best Available Control Measures (BACM) and Most Stringent Measure (MSM) requirements. In fact, EPA approved Rule 4311 as satisfying all applicable federal requirements on November 3, 2011.[43] However, due to the need to demonstrate attainment for multiple federal ozone and PM2.5 standards in the coming years and the need to search for all available emissions reductions, the District committed to undertaking a comprehensive review of FMPs submitted under Rule 4311, publish a draft report for public review and commenting

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[41] SJVAPCD. (2014) *Rule 4311 (Flares) Further Study 2014*. Retrieved from http://www.valleyair.org/Air_Quality_Plans/docs/R4311.pdf.
[42] SJVAPCD. (2015). *2015 Plan for the 1997 PM2.5 Standard*. Retrieved from http://www.valleyair.org/Air_Quality_Plans/PM25Plans2015.htm
[43] EPA. 76 Federal Register 213, 68106-68107. 11/3/2011. http://www.gpo.gov/fdsys/pkg/FR-2011-11-03/pdf/2011-28391.pdf

on December 1, 2015, and finalize the report on March 31, 2016 after receiving input from flare operators and addressing public comments. That comprehensive study resulted in the following findings and recommendations:

1. **The District identified minimization practices currently performed at facilities that have the potential to be applied to other facilities.**

   a. **The District recommends conducting a thorough evaluation of the most effective flare minimization practices included in approved FMPs and requiring the implementation of these practices where technologically achievable and economically feasible**.

      Even though operators of flares in the Valley have already taken extensive measures to reduce flaring, through this study the District has identified effective minimization practices currently performed at some facilities that could be employed at other facilities to further reduce flaring. To further evaluate opportunities for emission reductions from flaring, the District will commit to performing an exhaustive evaluation of these flare minimization practices and propose potential rule amendments requiring the use of these practices where technologically achievable and economically feasible.

   b. **The District recommends exploring options to further promote the implementation of the most effective flare minimization practices during the FMP submittal and review process.**

      Under Rule 4311, FMPs are required to be submitted and approved for existing, new, and modified flaring systems. For existing systems, an updated FMP is required to be submitted and approved every five years. Working with operators to identify potential flare minimization practices during the FMP review process provides operators the opportunity to incorporate feasible flare minimization practices when new and modified systems are proposed and during the ongoing review of FMPs.

2. **Ultra-low NOx technologies with the potential to further reduce emissions from flaring have recently become available. The District recommends conducting a thorough evaluation of new ultra low NOx control technologies for flaring and requiring the implementation of these technologies where technologically achievable and economically feasible.**

   Through this further study, the District has identified new low NOx control technologies that may serve as suitable options for further reducing NOx emissions from flaring in the San Joaquin Valley. To further evaluate opportunities for emission reductions from flaring, the District will perform an exhaustive evaluation of NOx emission reduction control technologies and propose potential rule amendments requiring the use of these technologies where technologically achievable and economically feasible.

Given the enormity of reductions needed to develop plans that demonstrate attainment with the latest federal ozone and PM2.5 standards and based on findings from the recent flare further study, the District committed in its 2016 Ozone Plan to work closely with affected operators to undergo a regulatory amendment process for Rule 4311 to amend Rule 4311 to include:

- Additional ultra-low NOx flare emission limitations for existing and new flaring activities at Valley facilities to the extent that such controls are technologically achievable and economically feasible, and
- Additional flare minimization requirements to the extent that such controls are technologically achievable and economically feasible

This regulatory amendment process began last year, with the District hosting a scoping meeting on August 23, 2017. The District is in the process of working with stakeholders to evaluate the feasibility of additional flare minimization practices and ultra-low NOx flare technologies.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.16	0.16	0.16	0.16	0.16	0.17	0.17	0.17	0.16
NOx	0.56	0.55	0.54	0.53	0.53	0.52	0.52	0.52	0.56
	Winter Average - Tons per day								
PM2.5	0.16	0.16	0.16	0.16	0.16	0.17	0.17	0.17	0.16
NOx	0.56	0.55	0.54	0.53	0.53	0.52	0.52	0.52	0.56

Source Category

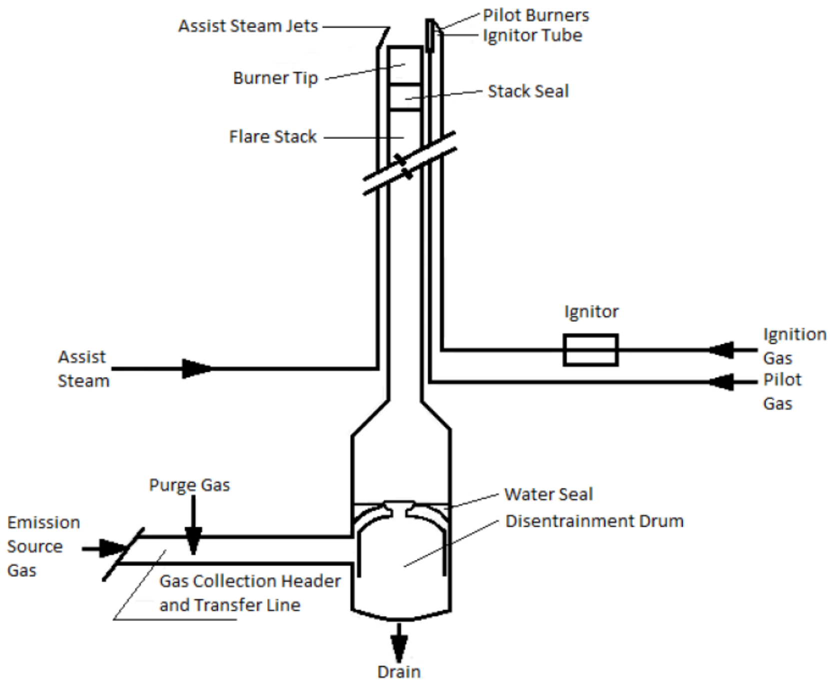
Flaring is a high temperature oxidation process used to burn combustible components, primarily hydrocarbons, of waste gases from industrial operations, primarily for the purpose of controlling emissions and as a safety device. The majority of waste gases flared are natural gas, propane, ethylene, propylene, butadiene and butane.

Combustion efficiency depends on flame temperature, residence time in the combustion zone, vent gas flammability, auto ignition temperature, heating value, and turbulent mixing. When operated at an optimal combination of these factors, flares have a destruction efficiency of 98 percent or greater. Complete combustion converts all VOCs to CO_2 and water; however incomplete combustion increases the presence of air pollutants such as carbon monoxide and particulate matter (as soot). Additionally, there is a possibility of pass through of hydrocarbons or H_2S if they have not been completely combusted. To prevent the creation of smoke or soot, which is influenced by fuel characteristics and the amount and distribution of oxygen in the combustion zone, most industrial flares are steam-assisted or air-assisted. In some cases, another fuel must be added to flare gas to achieve the minimum heating value of 200-250 Btu/ft^3 (or higher) required for complete combustion.

There are two general types of flares: elevated and enclosed ground flares. Flares are further categorized by the method of enhancing combustion by mixing at the flare tip (i.e., steam-assisted, air-assisted, pressure-assisted, or non-assisted).

Elevated flares are more common in the Valley and have larger capacities than enclosed ground flares. In an elevated flare, a waste gas stream is fed through a stack and is combusted near the tip of the stack. An elevated flare consists of five components: a gas collection header (to collect gases from various process units); a proprietary seal; a water seal, or purge gas supply (to prevent flash back); a single or multiple-burner unit in the flare stack; and gas pilots and an igniter. Figure 1, below, depicts a typical configuration for a steam-assisted elevated flare.

Figure 1. Flare Diagram



Enclosed ground flares, are less common in the Valley, vary in complexity and can consist of either conventional flare burners discharging horizontally with no enclosures or multiple burners in refractory-lined steel enclosures.

Flaring in the San Joaquin Valley

Flares serve two basic functions: as a safety device during unforeseeable and unpreventable emergency situations/standby situations and less commonly as a primary emissions control device for VOC emissions. As safety devices, flares are necessary to prevent catastrophic consequences such as the release of toxic gases and explosions, which could result in loss of property, injury, and loss of human life.

In the Valley, the vast majority of flares are employed in oil and gas production operations as emergency/standby control devices, which is in direct contrast with other regions, such as North Dakota, where flares are used for primary disposal of waste gas from oil and natural gas production. Also, while regions like North Dakota utilize flares to combust associated gas during the initial extraction phase of the production process (i.e., directly from the well), Valley flares are typically used further down the process chain, primarily as a safety device associated with gas collection systems, resulting in far lower quantities of flared gas.

Valley operators have generally evaluated all feasible and cost effective options for handling and disposing of the associated/waste gases generated by their facilities and installing a flare as the primary method of disposal would be the last resort. In addition to Rule 4311 requirements to evaluate and implement all feasible measures to reduce flaring activities, other associated rules also implement stringent capture and control of these gases. Therefore, most facilities have made significant investments to capture and utilize these process gases in a variety of methods and this ability has allowed facilities to maximize income generation. Some capture and treat these gases and sell them to natural gas/utility providers (generates monetary income), while others utilize these gases on-site to fuel equipment that generates electricity and/or provides process heating (saves fuel costs). In fact, most Valley facilities regard flaring events as a significant monetary cost, through directly lost profits or increased fuel costs.

In the District's evaluation of Valley flaring activities,[44] nearly all of the significant flaring events were either one-time events due to new control equipment installation or maintenance of existing equipment, and therefore not repeated, or in response to emergency situations or process upsets. For example, one Valley facility (light oil production facility) experienced abnormally high flaring due to the sales transmission pipeline being offline for repairs. Another facility (wastewater treatment plant) normally uses the fuel onsite to produce electricity and process heating but could not do so because additional air pollution control devices were being installed.

Flares in the Valley subject to the requirements in Rule 4311 are employed by a diverse group of industries for a wide variety of applications, as illustrated by the below list. In contrast, other air districts' flare rules generally limit the applicability of their rules to petroleum production facilities or refineries.

- Gas plants
- Heavy oil production/ thermally enhanced oil recovery

[44] SJVAPCD. *Rule 4311 (Flares) Further Study*. http://valleyair.org/Air_Quality_Plans/docs/R4311.pdf.

- Light oil production
- Refinery operations
- Wastewater treatment plants
- Cheese production
- Wine
- Dairy operations
- Flat glass production
- Correctional facility

HOW DOES DISTRICT RULE 4311 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There are no EPA CTG or ACT requirements for this source category.

The following federal regulations apply to Rule 4311 sources:

- NESHAP/MACT:
  - 40 CFR 63 Subpart SS (National Emission Standards for Closed Vent Systems, Control Devices, Recovery Devices and Routing to a Fuel Gas System or a Process)
- NSPS:
  - 40 CFR 60.18 (General Control Device and Work Practice Requirements)
  - 40 CFR 65.147 (Flares)
  - 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)
  - 40 CFR 60 Subpart Ja (Standards of Performance for Petroleum Refineries for Which Construction, Reconstruction, or Modification Commenced After May 14, 2007)

Rule 4311 is as stringent as or more stringent than the above NSPS and NESHAP requirements. The most recently amended NSPS (40 CFR 60 Subpart OOOO and 40 CFR 60 Subpart Ja) are discussed below.

40 CFR 60 Subpart OOOOa is a relatively new NSPS requirement that became effective on September 15, 2015. This NSPS may indirectly affect some Valley flares since there is a possibility that a flare is exempt from the majority of the requirements of Rule 4311 and is used as a control device for a vapor controlled tank that is subject to Subpart OOOOa.

Affected facilities under this subpart that may use flares as an approved control device include centrifugal compressors, storage vessels, and onshore natural gas processing plants. If the facility chooses to meet the control requirements, then the flare must be designed and operated in accordance with §60.18(b) and must conduct the compliance determination using Method 22 at 40 CFR part 60, appendix A-7, to determine visible emissions. §60.18(b) was last amended on December 22, 2008, which is before the last amendment for District Rule 4311 (June 18, 2009). The requirements of the 2008 amendments were closely evaluated during the District's 2009 Rule amendment. EPA deemed Rule 4311 as being at least as stringent as established RACT requirements on January 10, 2012.[45] Since Subpart OOOOa has no new requirements for flares after the 2012 EPA RACT approval, Rule 4311 continues to be at least as stringent as these requirements.

40 CFR 60 Subpart Ja was amended by EPA on September 12, 2012. Amendments clarified existing requirements and applicability, including what constitutes a flare modification, clarification of secondary flares, and clarification of the records that must be maintained by the operator. EPA also added new requirements to Subpart Ja as part of these amendments, including flare related unit and process descriptions, assessments, and evaluations; analyses of causes and corrective actions for reportable flaring events; and sulfur limits for petroleum refineries.

Subpart Ja did not implement more stringent requirements than District Rule 4311. Subpart Ja has one new exemption for continuous monitoring, which allows for fewer requirements than previously required in the NSPS, and therefore, is not more stringent than current rule language. While there may be some minor differences in terminology or requirements making direct comparisons not possible, the same level of controls and emission reductions are achieved through District regulations as through this NSPS. Additionally, the District's Permit Services Department continuously evaluates NSPS on a case-by-case basis to ensure the relevant flares comply with all federal requirements as they are promulgated. Rule 4311 is as stringent as, if not more stringent than, this NSPS.

As demonstrated by the discussion above, Rule 4311 is as stringent as or more stringent than the applicable federal regulations.

State Regulations
There are no analogous state regulations for this source category.

HOW DOES DISTRICT RULE 4311 COMPARE TO RULES IN OTHER AIR DISTRICTS?

As previously stated, EPA analysis of Rule 4311 resulted in the 2012 determination that Rule 4311 is as stringent as requirements in other air districts in California (76 FR 68106); however, in keeping with the methodology of this plan, the District conducted a thorough examination of rules in other air districts, including the following:

- BAAQMD Regulation 12 Rule 12 (Flares at Petroleum Refineries)
- SCAQMD Rule 1118 (Control of Emissions from Refinery Flares)
- SMAQMD and VCAPCD do not have an analogous rule for this source category.

[45] EPA. (2012, January 10). 77 FR 1417. Retrieved 2/11/15 from http://www.gpo.gov/fdsys/pkg/FR-2012-01-10/pdf/2012-139.pdf.

The District also conducted an exhaustive search for rules in all other air districts, including those outside of California, to identify any that might contain more stringent requirements.

The District prepared comparisons to Santa Barbara County Air Pollution Control District (SBCAPCD) Rule 359 and North Dakota Century Code 38-08-06.4. The following table compares major elements of Rule 4311 with those in other California air districts and the North Dakota rule.

SCAQMD

- South Coast AQMD Rule 1118 (Control of Emissions from Refinery Flares) *(Adopted Feb 13, 1998; Amended Nov 4, 2005, July 7, 2017)*

The District compared the requirements of District Rule 4311 with the requirements contained within SCAQMD's Rule 1118 and found no requirements that were more stringent than those already in Rule 4311.

	SJVAPCD	SCAQMD
Applicability	All flares	Flares used at: • Petroleum (petro.) refineries • Sulfur recovery plants • Hydrogen production plants
Exemptions	• Municipal solid waste landfill flares subject to Rule 4642 • Flares subject to 40 CFR 60 WWW or Cc • Stationary sources w/ potential to emit <10 tons VOC and <10 tons NOx per year (Not exempt from recordkeeping)	Exempt from sampling and analyses for higher heating values and sulfur concentration for flare event that: • Results from catastrophic event • Is safety hazard to sampling personnel; Sulfur dioxide (SO_2) emissions (emissions) 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)

	SJVAPCD	SCAQMD
Requirements	For sources greater than 10 tpy NO_x or VOC: Open flares (air-assisted, steam-assisted, or non-assisted): Comply with 40 CFR 60.18: Ground level enclosed flares without steam assist: 0.0051 lb-VOC/MMBtu, 0.0952 lb-NOx/MMBtu (<10 MMBtu/hr); 0.0027 lb-VOC/MMBtu, 0.1330 l-NOx/MMBtu (10-100 MMBtu/hr); 0.0013 lb-VOC/MMBtu, 0.5240 lb-NOx/MMBtu (> 100 MMBtu/hr). Ground level enclosed flares with steam assist: 0.14 lb-VOC/MMBtu (as TOG), 0.068 lb-NOx/MMBtu (all ratings); Recordkeeping and reporting; Flare minimization plan for refinery flares or flares ≥ 5.0 MMBtu/hr at major sources of NO_x or VOC.	No emission limit requirements

BAAQMD

- Bay Area AQMD Rule 12-12 (Flares at Petroleum Refineries) *(Adopted Jul 20, 2005, amended Apr 5, 2006)*

The District compared the requirements of District Rule 4311 with the requirements contained within BAAQMD's Rule 12-12 and found no requirements that were more stringent than those already in Rule 4311.

	SJVAPCD	BAAQMD
Applicability	All flares	Flares used at petroleum refineries
Exemptions	• Municipal solid waste landfill flares subject to Rule 4642 • Flares subject to 40 CFR 60 WWW or Cc • Stationary sources w/ potential to emit <10 tons VOC and <10 tons NOx per	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)

	SJVAPCD	BAAQMD
	year (Not exempt from recordkeeping)	• 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) Monitoring and reporting total hydrocarbon (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	For sources greater than 10 tpy NO_x or VOC: Open flares (air-assisted, steam-assisted, or non-assisted): Comply with 40 CFR 60.18: Ground level enclosed flares without steam assist: 0.0051 lb-VOC/MMBtu, 0.0952 lb-NOx/MMBtu (<10 MMBtu/hr); 0.0027 lb-VOC/MMBtu, 0.1330 l-NOx/MMBtu (10-100 MMBtu/hr); 0.0013 lb-VOC/MMBtu, 0.5240 lb-NOx/MMBtu (> 100 MMBtu/hr). Ground level enclosed flares with steam assist: 0.14 lb-VOC/MMBtu (as TOG), 0.068 lb-NOx/MMBtu (all ratings); Recordkeeping and reporting;	No emission limit requirements

	SJVAPCD	BAAQMD
	Flare minimization plan for refinery flares or flares ≥ 5.0 MMBtu/hr at major sources of NO_x or VOC.	

SBAPCD

- SBAPCD Rule 359 (Flares and Thermal Oxidizers) *(Adopted Jun 28, 1994)*

SBCAPCD Rule 359 was adopted on June 28, 1994. Provisions of this rule apply to the use of flares and thermal oxidizers at oil and gas production sources, petroleum refinery and related sources, and natural gas services. Rule 359 sets specific requirements for the sulfur content in gaseous fuels, technology based standards, flare minimization plans, emergency events, and emission and operational limits.

The District compared the requirements of District Rule 4311 with the requirements contained within SBAPCD's Rule 359 and found no requirements that were more stringent than those already in Rule 4311.

	SJVAPCD	SBAPCD
Applicability	All flares	Flares and thermal oxidizers used at: • Oil and gas production • Petro. refinery • Natural gas services and transportation • Wholesale trade in petro./petro. Products •
Exemptions	• Municipal solid waste landfill flares subject to Rule 4642 • Flares subject to 40 CFR 60 WWW or Cc • Stationary sources w/ potential to emit <10 tons VOC and <10 tons NOx per year (Not exempt from recordkeeping)	Burning of sulfur, hydrogen sulfide, acid sludge, or other sulfur compounds in manufacturing of sulfur or sulfur compounds For oil and gas sources that recover sulfur as by-product of gas treating/sweetening, manufacturing exemption applies only to those specific processes (Except technology-based std.) Burning gas w/ net heating value <300 Btu/scf if fuel used to

	SJVAPCD	SBAPCD
		incinerate gas has sulfur compounds: • <15 grain/100 ft3 in Southern Zone • <50 grain/100 ft3 in Northern Zone Flare and thermal oxidizer units rated ≤1.7 MMBtu/hr., unless total cumulative rating of all such units at a source is ≥5 MMBtu/hr. (Not exempt from sulfur content std., technology std., monitoring, recordkeeping, and recording.) Flares and thermal oxidizers exempt from FMP: • Rated at <15 MMBtu/hr, unless cumulative rating >50 MMBtu/hr. Operations of only planned, continuous flaring due to non-availability of a produced gas pipeline outlet
Requirements	For sources greater than 10 tpy NO_x or VOC: Open flares (air-assisted, steam-assisted, or non-assisted): Comply with 40 CFR 60.18: Ground level enclosed flares without steam assist: 0.0051 lb-VOC/MMBtu, 0.0952 lb-NOx/MMBtu (<10 MMBtu/hr); 0.0027 lb-VOC/MMBtu, 0.1330 l-NOx/MMBtu (10-100 MMBtu/hr); 0.0013 lb-VOC/MMBtu, 0.5240 lb-NOx/MMBtu (> 100 MMBtu/hr). Ground level enclosed flares with steam assist: 0.14 lb-VOC/MMBtu (as TOG), 0.068 lb-NOx/MMBtu (all ratings); Recordkeeping and reporting;	Sulfur limits on planned flaring of 15 gr (as H_2S) in Southern Zone, 50 gr (as H_2S) in Northern Zone. FMP for flares ≥ 15 MMBtu/hr. Ground level enclosed flares without steam assist: 0.0051 lb-VOC/MMBtu, 0.0952 lb-NOx/MMBtu (<10 MMBtu/hr); 0.0027 lb-VOC/MMBtu, 0.1330 l-NOx/MMBtu (10-100 MMBtu/hr); 0.0013 lb-VOC/MMBtu, 0.5240 lb-NOx/MMBtu (> 100 MMBtu/hr). Ground level enclosed flares with steam assist: 0.14 lb-VOC/MMBtu (as TOG), 0.068 lb-NOx/MMBtu (all ratings)

	SJVAPCD	SBAPCD
	Flare minimization plan for refinery flares or flares ≥ 5.0 MMBtu/hr at major sources of NO_x or VOC.	

Rule 350 Section D.3 requires a FMP be submitted by any source subject to this rule that operates a flare rated at 15 MMBtu/hour or greater. For planned flaring, the FMP for all sources subject to this rule shall list a targeted maximum monthly flared gas volume, which shall not exceed 5% of the average monthly gas handled/produced/treated at the source unless the operator demonstrates such a maximum volume to be infeasible based on safety, engineering or cost constraints and proposes a different percentage. Any flaring that causes an exceedance of the emission limits or standards of Rule 359 is also not considered to be in violation if the operator demonstrates that the exceedance resulted from an emergency event.

Additionally, under SBCAPCD Rule 359, flares for which flaring operations solely consist of planned, continuous flaring due to the non-availability of a produced gas pipeline are exempt from FMP requirements.

Although FMPs in SBCAPCD Rule 359 are required to list a targeted maximum monthly flared gas volume of five percent (5%) of the average monthly gas handled/produced/treated, the operator can obtain approval of a higher percentage by demonstrating that the maximum flare volume limit is infeasible based on safety, engineering, or cost constraints, which leaves the rule open to allow a higher amount of flaring. The District evaluated the percentage of gas flared in the Valley and found that the average percentage of gas flared between 2009 and 2013 was well below SBCAPCD's 5% theoretical level at 3.8% as shown in the table below.

Table C-1 Percent of Gas Flared at Valley Facilities

Year Of Data	Gas Produced (MCF)	5% Flared (if meeting SBCAPCD target) (Mscf)	Actual Flared (Mscf)	Percent of gas flared
2009	223,220,118	11,161,006	7,134,977	3.2
2010	241,676,822	12,083,841	7,884,879	3.3
2011	240,000,594	12,000,030	8,324,237	3.5
2012	216,232,509	10,811,625	10,147,080	4.7
2013	238,058,188	11,902,909	10,581,415	4.4
			Total Average Percent of Gas Flared in Valley	**3.8%**

In addition, unlike SBCAPCD rule 359, Rule 4311 does not allow an exceedance of any emissions limits or the requirement to minimize flaring activity, regardless of the cause. Allowing such a measure in the Valley would result in a serious relaxation of rule requirements and a potential increase in emissions. Under the District's rule, any exceedance or excess flaring not allowed under Rule 4311, regardless of the cause, would result in a violation and be subject to enforcement action. Flares subject to SBCAPCD Rule 359 whose flaring operations solely consist of planned, continuous flaring due to the non-availability of a produced gas pipeline outlet are also exempt from FMP requirements while such flares subject to Rule 4311 are not exempt from FMP requirements and are still required to identify and implement actions that reduce flaring.

Based on the discussion above, District Rule 4311 is clearly more stringent than SBCAPCD Rule 359 for the following reasons:

- Rule 4311 applies to a broader range of sources than SBCAPCD Rule 359
- SBCAPCD Rule 359 includes a performance standard for the volume of gas flared (5%), but also includes APCO discretion for allowing unlimited flaring activity
- SBCAPCD Rule 359 contains several exemptions not allowed in Rule 4311, including the allowance for exceedance of emission limits
- EPA analysis resulted in the 2012 determination that Rule 4311 is as stringent as requirements in SBCAPCD Rule 359 in terms of core RACT requirements
- Overall, Rule 4311 results in significantly less flared gas relative to flaring capacity in the District as compared the allowable levels of flaring under SBCAPCD

State of North Dakota

- Century Code 38-08-06.4[46]
- Industrial Commission Order[47]

North Dakota Century Code 38-08-06.4 applies to flaring of gas produced with crude oil from an oil well. The North Dakota rule allows for the uncontrolled flaring of all gases during the first year after opening a new crude oil production well, after which flaring of the entire volume of gas must cease and the well must be:

- Capped;
- Connected to a gas gathering line;
- Equipped with an electrical generator that consumes at least seventy-five percent (75%) of the gas from the well;
- Equipped with a system that intakes at least seventy-five percent (75%) of the gas and natural gas liquids volume from the well for beneficial consumption by means of compression to liquid for use as fuel, transport to a processing facility, production of petrochemicals or fertilizer, conversion to liquid fuels, separating

[46] North Dakota Legislative Branch. (2013, August). *Century Code 38-08-06.4 Flaring of Gas Restricted – Imposition of Tax – Payment of Royalties – Industrial Commission Authority. Retrieved February 13, 2015 from* http://www.legis.nd.gov/cencode/t38c08.pdf?20150213153521.
[47] North Dakota Industrial Commission. (2014, July 1). *Order of the Commission*. Obtained February 3, 2015 from https://www.dmr.nd.gov/oilgas/or24665.pdf.

and collecting over fifty percent (50%) of the propane and heavier hydrocarbons; ***or***

- Equipped with other value-added processes as approved by the industrial commission, which reduce the volume or intensity of the flare by more than sixty percent (60%).

The intent of this rule is to minimize the "waste" of a natural resource, and to assure that mineral rights owners were compensated for the oil and gas produced from their properties. This rule had a collateral benefit of reducing emissions from flaring activities.

Because of large amount flaring that has historically occurred in North Dakota, the North Dakota Industrial Commission acted on a motion of the commission to consider amending the current oil production rule to reduce the amount of flared gas by issuing an order in July 2014 to increase gas capture from oil wells. The order requires 74% of gas capture (instead of flaring) by October 2014, 77% by January 2015, 85% by 2016, and 90% by 2020. By contrast, in the Valley, the quantity of gas captured is over 96%, i.e. only approximately 3.8% of gas produced is flared (see table above).

Due to the mature nature of oil production operations in the Valley, many of the sources subject to Rule 4311 design and operate their equipment and processes in a manner that inherently results in minimal flaring activity. Flare gas is typically flared further along in the process, rather than directly from production wells, resulting in less flaring activity. In contrast, sources in North Dakota flare large portions of the gas generated at oil production wells. This is oil production method is often seen in regions with little to no history of emission regulations and/or no pipeline infrastructure to transport produced gasses.

The District has two rules specific to the operation of crude oil wells. Rule 4401 (Steam-Enhanced Crude Oil Production Wells) and Rule 4409 (Components at Light Crude Oil Production Facilities, Natural gas Production Facilities, and Natural Gas Processing Plants). These rules contain control requirements including a minimum 95% capture and control, periodic leak detection, and repair requirements for steam enhanced wells and light oil wells. These rules also require the development of an Operator Management Plan (OMP) that describes how a facility will comply. The OMP must be updated annually to reflect any changes to the OMP, including changes to address newly installed wells. These prohibitory rules are applicable to both existing and new wells.

As discussed above, Rule 4311, and the common practices of the mature local oil production operations to recover the vast majority of produced gas, are more stringent than the North Dakota rule.

Additional Emission Reduction Opportunities

Ultra-Low NOx Flares

While the modernization of flare technology will not reduce the frequency or volume of flaring activities, it can reduce the emissions from such activities, thereby accomplishing the same end goal.

The District has identified a new class of VOC destruction devices that are similar to enclosed flares but operate with mixing controls and are being put into practice as control devices. These devices offer ultra-low NOx emissions of approximately 0.018 – 0.025 lb-NOx/MMBtu (compared to existing District Rule 4311 requirement of 0.068 lb-NOx/MMBtu). These devices may not be considered flares by the Rule 4311 definition, but are an alternative method for VOC control. One Permit to Operate and at least eight Authority to Construct permits have been issued to facilities in the Valley for these new devices.

These devices appear more suitable for use at sites with more steady gas disposal needs. These new devices may not be a viable replacement for some emergency flares, particularly those with high intermittent gas volume capacity requirements.

Cost effectiveness varies depending on usage rates. For example, based on cost information from E&B Natural Resources, the cost for a 3.4 MMBtu/hr flare is estimated at $800,000 (capital and installation) with $1,000 monthly ongoing operational costs. Assuming an average $1.2 million initial cost estimate to account for larger flares, the annualized cost effectiveness ranges from $23,000 per ton of NOx reduced to as high as $1,000,000 per ton of NOx reduced, depending on flare usage.

Flare Minimization Practices
District staff conducted a detailed review of all approved FMPs to identify the variety of flare minimization practices used by affected facilities. In addition, District staff also worked closely with affected facilities to gain more in-depth understanding of the minimization practices. The District found a variety of flare minimization practices specific to each facility that could potentially be employed at other facilities to further reduce flaring at their operations. These practices may not only serve to reduce flaring activities and associated emissions but may also provide economic, safety, and other benefits to affected facilities. Because of the unique nature of each facility, the technological achievability and economic feasibility of transferring these minimization practices or technologies from one facility to another needs to be considered.

Even though operators of flares in the Valley have already taken extensive measures to reduce flaring, the District is currently undergoing a robust public process to amend Rule 4311 to evaluate and require the use of these practices where technologically achievable and economically feasible.

Alternatives to Flaring
The following alternative uses for flare gas were identified in submitted FMPs.

- **Use gas as a fuel for equipment rather than flaring.** Capturing gas and routing it into a fuel gas system to power various processes is a means of utilizing gas that would otherwise be flared. There is a financial incentive to utilize this practice to the greatest extent feasible across all facility types as the gas can be used to supplement, or in some cases even completely supply, the process energy needed, (i.e. IC engines) to produce electricity, and boilers for steam generation and process heating.

While many oil production operations in the Valley do use produced gas in their steam generation operations, there are several barriers to implementing this practice in all situations where gas is currently flared. Some facilities do not have a use for combustion equipment on-site. For those that do have a use for the combustion equipment, it may not be economically feasible to purchase, install and operate such equipment, the multiple stages of treatment equipment to make the gas suitable for use at the facility, and the infrastructure required to connect process streams and utilities to the fuel gas system. Additionally, the installation of extra equipment to handle the waste gas can potentially add more complexity to the maintenance and testing, and can increase the number of potential points of failure.

- **Injection of oil field gas into DOGGR-approved disposal wells**. Reinjection of gas into subsurface geologic formations disposal wells is a potential alternative to flaring. These wells are regulated by the California Department of Conservation, Division of Oil, Gas and Geothermal Resources (DOGGR). However, the permits for these wells can be extremely difficult to obtain from the state, and require significant capital investment to complete the various studies and installation of infrastructure in California. Additionally, the permits place a limit on volume reinjected that if exceeded requires the facility to dispose of gas by other means.

- **Send oilfield gas to a sales gas line**. Gas that is of high enough quality (i.e. high energy content, low sulfur or nitrogen content) can be sold through a sales gas line. While many oil production operations in the Valley do sell their produced gas, there can be many barriers associated with implementing this alternative including proximity to an existing gas line, quantity and quality of gas generated, and the economics of purchasing, installing, and maintaining a new sales gas line and all the associated treatment and transmission equipment and infrastructure.

Preventative Maintenance

A proactive and preventative maintenance program can greatly reduce flaring by minimizing downtime from equipment failure which can lead to flaring of produced gas. The following preventative maintenance practices were identified in submitted FMPs to minimize flaring.

- **Implement a preventative maintenance program to predict failure in pipelines and stationary equipment (measure corrosion)**. The gas going through pipelines and stationary equipment can be very corrosive. A predictive method such as using x-rays to measure pipe thickness is used to determine when to replace the equipment. This testing is performed on a periodic basis as dictated by the equipment type and the service it is in.

- **Install high-pressure alarms on process vessels**. Installation of alarms on process vessels can indicate a high pressure build-up (before pressure relief valves opens and directs gasses to flares) so that operators can intervene before flaring occurs.

- **Inspect pressure relief valves routinely to ensure proper operation**. If a pressure relief valve improperly seats or is otherwise defective, gases will leak and be combusted in the flare. In an attempt to reduce such occurrences, the pressure relief valves can be inspected periodically.

- **Maintain and calibrate flare gas control valves on a routine schedule**. Flare gas lines are typically equipped with control valves to regulate the volume of gas going to flares. Should these valves malfunction, it is possible that excessive gas would be directed to the flare. These valves could be calibrated on a routine schedule.

- **Retain spare parts onsite to minimize system downtime**. Quick and easy access to spare parts reduces equipment downtime and associated flaring. While the economic feasibility of purchasing and maintaining backup equipment will need to be considered on a case-by-case basis for each facility, some facilities maintained the following types of equipment onsite to minimize flaring:

    - **Compressors**. Compressors are ubiquitous in the gas and petroleum industry and play a critical role in many different stages of oil and gas production, processing/refining, and transmission.

    - **Sulfur scrubber components/media**. If the sulfur scrubber system is down, the fuel cannot be processed for onsite use and must be flared instead.

    - **Spare parts for primary combustion equipment (blowers, etc.)**. If the primary combustion equipment is down, the fuel cannot be utilized onsite and must be flared instead.

Procedures to Reduce Flaring During Maintenance and Shutdowns

Another effective flare minimization measure is to optimize and coordinate maintenance activities so that equipment failure and downtime is minimized to the extent feasible. A proactive and preventative maintenance program can greatly reduce downtime and thereby minimize flaring. However, during maintenance and shutdown events, operators can take additional measures to avoid or reduce flaring. The following procedures were identified in submitted FMPs.

- **Perform maintenance on one area without impacting other operations on site.** Designing a facility in a manner that allows maintenance to be performed in one area of a facility without affecting other operations can reduce flaring. This allows the other operations to continue normally without the need to flare excess gas.

- **Curtail oil/gas production during planned shutdown of sales line**. In the event of a planned shutdown of a sales gas pipeline, and/or major maintenance activities, oil/gas production can be curtailed. This could potentially result in lost revenue.

- **Close oil well casing vents during vapor control system maintenance**. Casing gas remains in reservoir instead of being flared, but this can potentially result in reduced oil production rate until vents are opened.

- **Store gas in bladder tank.** For waste water treatment plants, limited amounts of digester gas can be stored in bladder tanks during maintenance, testing, or process upsets and later be routed to combustion devices for beneficial use on-site.

- **Plan maintenance activities during optimal periods.** Scheduling maintenance during periods of minimum capacity needs and/or following planned process unit shutdowns has the potential of minimizing flaring activities.

- **Optimize planned shutdowns for major maintenance.** Most inspection, repair, and minor maintenance work can be performed while a facility is in operation. However, there are times when a facility has to shut down and flare process gas to conduct major maintenance work. The management of a facility shutdown is known as a “turnaround”. Scheduled facility shutdowns are expensive and labor intensive due to the loss of production and the expense of the turnaround itself. While turnaround procedures are primarily focused on minimizing downtime, the following specific procedures were identified in submitted FMPs to minimize flaring during plant turnaround.
    - Have extra personnel on site to re-start the plant as quickly as possible
    - Recycle discharge gas back to compressor inlets until minimum operating pressure is obtained
    - Prior to turnaround, identify critical equipment to be serviced to avoid refinery downtime and associated flaring
    - Phase equipment and process unit shutdowns to minimize fuel gas imbalances that may result in additional flaring
    - Identify alternate disposition of process gases to minimize flaring;
    - Identify key process unit operations such as fuel gas systems and sulfur recovery operations that must remain in operation to minimize flaring of sulfur-containing gases

Phase equipment and process unit start-ups to minimize start-up duration and the flaring associated with these transitional operations

Redundant Systems

Even with the most rigorous and proactive maintenance programs in place, there is always the potential for critical equipment failure. Installing redundant systems minimizes the potential of downtime by allowing operators to quickly switch from one system to another in the event of equipment failure or during maintenance. The following redundant systems were identified in FMPs to minimize flaring.

- **Redundant compressors.** Compressors can fail, and as a result the gas may need to be flared. Installation of a redundant secondary compressor can minimize flaring when the primary compressor is down.

- **Redundant gas treatment systems (sulfur scrubber).** This allows gas to continue to be treated and burned in combustion equipment when one unit is not available.

- **Redundant digester gas-fired turbines.** Some wastewater treatment plants have incorporated redundant digester-gas-fired turbines into their system design. The redundant system allows the turbines to be maintained without the need to flare. This has potential to reduce a considerable amount of flaring, as the turbines for these types of operations typically require frequent maintenance. In addition, a redundant system reduces downtime and extends the life of the turbines.

Procedures to Prevent or Mitigate the Effects of Power Outages to Reduce Flaring
A power outage has the potential to result in flaring as vapors are sent to flares to protect the facility from being over-pressurized. The following specific procedures were identified in submitted FMPs to mitigate the effects of power outages and reduce flaring.

- **Backup generators.** Install emergency IC engine/generators to power equipment during power outages.

- **Power outage alarm.** Send alarms to all operators when power outage occurs to ensure rapid response.

- **Infrared testing.** Implement infrared testing of electrical equipment on a routine basis to identify hot-spots that could result in a power outage.

- **Avian guards.** Install avian guarding in substations to deter birds from contacting energized equipment.

EVALUATION FINDINGS

Even though flares are not a significant source of PM2.5 and NOx in the Valley, the District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans. As demonstrated above, Rule 4311 currently has in place the most stringent measures feasible to implement in the Valley.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will pursue the following potential opportunities that are projected to provide 0.05 tons NOx per day of additional emissions reductions towards the District's aggregate plan commitment. The District will continue to work closely with affected operators and other stakeholders to undergo a regulatory amendment process for Rule 4311 to include:

- Additional ultra-low NOx flare emission limitations for existing and new flaring activities at Valley facilities to the extent that such controls are technologically achievable and economically feasible, and
- Additional flare minimization requirements to the extent that such controls are technologically achievable and economically feasible
- Expand the applicability of the rule to apply to all sources (not limited to major sources)

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C.12 Rule 4313 (Lime Kilns)

Discussion
Lime kilns can be used in a variety of manufacturing and processing operations, including food and agriculture. In 2003, there were a total of three lime kilns in the Valley, used at two sugar processing plants; however, these plants have been non-operational since 2008. There are currently no lime kilns operating in the Valley.

Emissions Inventory
There is no emissions inventory associated with lime kilns because there are no lime kilns operating in the Valley. District staff have verified that there are no lime kilns in the preliminary permitting process to become operational in the Valley, nor are any lime kilns expected to be operated in the Valley in the future.

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

Federal Regulations
There are no EPA CTG or ACT requirements for this source category.

NSPS
- 40 CFR 60 Subpart HH (Standards of Performance for Lime Manufacturing Plants)

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.

NESHAP/ MACT
- 40 CFR 63 Subpart AAAAA (National Emission Standards for Hazardous Air Pollutants for Lime Manufacturing Plants)

The District evaluated the requirements contained within 40 CFR 63 Subpart AAAAA 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?
There are no lime kiln rules in SCAQMD, BAAQMD, SMAQMD, and VCAPCD.

Evaluation Findings
The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this source category. As demonstrated above, Rule 4313 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

C.13 Rule 4352 (Solid Fuel-Fired Boilers, Steam Generators, and Process Heaters)

Discussion

The purpose of Rule 4352 is to limit oxides of nitrogen (NOx) and carbon monoxide (CO) emissions from any boiler, steam generator or process heater fired on solid fuel. The adoption of Rule 4352 on September 14, 1994, established NOx limits of 200 parts per million volume (ppmv) for municipal solid waste facilities (MSW), 0.35 pounds per million British thermal units per hour (lb/MMBtu) for biomass facilities, and 0.20 Ib/MMBtu for all other solid fuel fired units. Since its adoption, the rule has been amended three times. The most recent amendments, in December 2011, strengthened the rule by lowering NOx emissions limits for all three source categories. However, no emissions reductions were quantified because the rule amendments were meant to satisfy EPA RACT requirements and all units were determined to be operating at the new emission limits. EPA finalized approval of Rule 4352 on November 6, 2012.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.64	0.75	0.83	0.86	0.87	0.90	0.92	0.94	0.96
NOx	2.49	2.85	3.07	3.18	3.20	3.28	3.35	3.43	3.49
	Winter Average - Tons per day								
PM2.5	0.65	0.76	0.84	0.87	0.88	0.91	0.93	0.95	0.97
NOx	2.77	3.14	3.36	3.47	3.49	3.58	3.65	3.73	3.79

Source Category

Boilers, steam generators, and process heaters are used in a broad range of industrial, commercial, and institutional settings. Units subject to this rule fire on a variety of solid fuels: coal, petroleum coke, biomass, tire-derived fuel, and municipal solid waste (MSW). The two primary methods of controlling NOx emissions from boilers, steam generators, and process heaters are either to change the combustion parameters to reduce NOx formation (i.e., combustion modification, lower combustion temperature, etc) or to treat the NOx formed in the process before the NOx is emitted into the atmosphere (i.e., post-combustion control or flue gas treatment). While previous rule-amending projects for Rule 4352 have not quantified specific emissions reductions, the use of biomass facilities in the Valley has fostered emissions reductions.

<u>Permitted Sources - Biomass</u>

Twelve biomass-fired units are currently permitted within the District; however, only five biomass-fired units are currently operating. All five operating units are used to generate electricity for electric utilities. The remaining seven units have been shut down and are dormant.

As an energy source, biomass can either be used directly or converted into other energy products such as biofuel. Biomass facilities in the Valley reduce the amount of pollutants created by open burning practices and the landfilling of potential biofuels such as agricultural materials, and urban and forest wood waste products by utilizing these materials.

Permitted Sources – Municipal Solid Waste

Two of the solid fuel-fired units permitted with in the District are fired on municipal solid waste. The municipal solid waste fired units are located at a single facility that generates electricity for electric utilities.

Permitted Sources – Other

One solid fuel-fired unit permitted with in the District may be fired on coal and petcoke. This particular unit is also permitted to be fired on biomass has been exclusively fired on biomass since 2013.

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

Federal Regulations
There are no EPA CTG or MACT requirements for this source category.

The District evaluated the requirements contained within the Clean Air Act (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.

The District evaluated the requirements contained within the NSPS in 40 CFR 60 Subpart Cb (Large Municipal Waste Combustors), Subpart D (Fossil-Fuel-Fired Steam Generators), and Subpart Db (Industrial-Commercial-Institutional Steam Generating Units) and found no requirements that were more stringent than those already in Rule 4352.

The NESHAP in 40 CFR 63 Subpart DDDDD (Industrial, Commercial, and Institutional Boilers and Process Heaters) was amended on January 31, 2013 to include new emission limits for PM, CO, and total selective metals (TSM), replace numeric dioxin emission limits with work practice standards, add new subcategories of facilities, and add alternative monitoring approaches. The District evaluated the requirements contained within this NESHAP and found no requirements that were more stringent than those already in Rule 4352 and required by District permits.

State Regulations
There are no California state regulations applicable to this source category.

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

There are no analogous rules for this source category in Ventura County APCD.

SCAQMD

- South Coast AQMD Rule 1146 (Emissions of Oxides of Nitrogen from Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters) *(Amended November 1, 2013)*

The District evaluated the requirements contained within SCAQMD Rule 1146 and the 40 ppmv @ 3% O_2 limit for non-gaseous fuels is potentially more stringent than those already in District Rule 4352. However, all of the remaining solid-fuel fired boilers operating within the Valley are used by electric utilities to generate electricity, a category which South Coast AQMD specifically exempts from the requirements of Rule 1146. Furthermore, it was determined that there are no biomass-fired power plants in South Coast District and there are two municipal solid waste-fired power plants generating electricity for electric utilities that are therefore not subject to 40 ppm requirement. In conclusion, no sources in SCAQMD are currently complying with the 40 ppmv limit of SCAQMD Rule 1146.[48] In summary, the District found no requirements that were more stringent than those already required by the District.

	SJVAPCD	SCAQMD
Applicability	NOx emission limit is applicable to 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
Exemption	NOx emission limits do not apply to units operated at a Stationary Source that has a potential to emit < 10 tpy of NOx	Units rated heat ≤ 5 MMBtu/hr. Boilers used by electric utilities to generate electricity. NOx emissions from RECLAIM facilities
Requirements Emission Limits	<u>Municipal Solid Waste</u> ≤ 165 ppmv NOx corrected to 12% CO_2 <u>Biomass</u> ≤ 90 ppmv NOx corrected to 3% O_2 <u>All others</u> ≤ 65 ppmv NOx corrected to 3% O_2	<u>Non-gaseous</u> < 40 ppmv NOx corrected to 3% O_2

[48] Approval and Disapproval of California Air Plan; San Joaquin Valley Serious Are Plan and Attainment Date Extension for the 1997 PM2.5 NAAQS. Final Rule. 81 Fed. Reg. 26, pp. 6936-6986. (2016, February 9) (to be codified at 40 CFR Parts 52 and 81) https://www.gpo.gov/fdsys/pkg/FR-2016-02-09/pdf/2016-02325.pdf and http://www.calbiomass.org/facilities-map/

BAAQMD

- 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)*

The District evaluated the requirements contained within BAAQMD Regulation 9 Rule 7 and the 40 ppmv @ 3% O_2 limit for non-gaseous fuels is potentially more stringent than those already in District Rule 4352. However, all of the solid-fuel fired boilers operating within the Valley are used by electric utilities to generate electricity or are qualifying small power producing facilities, a category which BAAQMD exempts from the requirements of Regulation 9, Rule 7. Therefore, the District found no requirements that were more stringent than those already required by District Rule 4352 for the categories of solid-fuel fired units located in the Valley.

	SJVAPCD	BAAQMD
Applicability	NOx emission limit is applicable to any boiler, steam generator or process heater fired on solid fuel	Boilers, steam generators, and process heaters with a rated heat input ≥ 1 MMBtu/hr used in all industrial, institutional, and commercial operations
Exemption	Stationary Source that has a potential to emit < 10 tpy of NOx	Boilers used by public electric utilities or qualifying small power production facilities, as defined in Section 228.5 of the PUC code, to generate electricity
Requirements Emission Limits	Municipal Solid Waste ≤ 165 ppmv NOx corrected to 12% CO_2 Biomass ≤ 90 ppmv NOx corrected to 3% O_2 All others ≤ 65 ppmv NOx corrected to 3% O_2	Non-gaseous fuel: ≤ 40 ppmv NOx corrected to 3% O_2

BAAQMD

- Bay Area AQMD Regulation 9 Rule 11 (Nitrogen Oxides and Carbon Monoxide from Utility Electric Power Generating Boilers) *(Adopted May 17, 2000)*

The District evaluated the requirements contained within BAAQMD Regulation 9, Rule 11 and found that the NOx limitations in Regulation 9 Rule 11 are more stringent than those already in District Rule 4352. However, there are no biomass facilities and no municipal solid-waste fired power plants in BAAQMD. Therefore no solid-fuel fired units in BAAQMD are currently complying with the BAAQMD Rule 411 limits for non-gaseous fuel.[49]

	SJVAPCD	BAAQMD
Applicability	NOx emission limit is applicable to any boiler, steam generator or process heater fired on solid fuel	NOx emission limit is applicable to any electric power generating steam boiler with rated heat input capacity ≥ 1.5 BBtu/hr
Exemption	Stationary Source that has a potential to emit < 10 tpy of NOx Duration of startup and shutdown period may not exceed 12 hours	Boilers with a rated heat input capacity < 0.250 MMBtu/hr Boilers ≥ 5 BBtu/hr during startup period may not exceed 20 hours unless catalytic reaction temperature has not been reached, if applicable Boilers with rated heat input capacity of < 5 BBtu/hr during startup period may not exceed 12 hours unless catalytic reaction temperature has not been reached, if applicable Duration of shutdown period may not exceed 8 hours
Requirements NOx Emission Limits	<u>Municipal Solid Waste</u> ≤ 165 ppmv NOx corrected to 12% CO_2 <u>Biomass</u> ≤ 90 ppmv NOx corrected to 3% O_2 <u>All others</u> ≤ 65 ppmv NOx corrected to 3% O_2	<u>Non-Gaseous Fuel (Boilers with rated heat input capacity ≥ 1.75 MMBtu/hr)</u> ≤ 25 ppmv NOx corrected to 3% O_2, and Boilers shall not be fired on non-gaseous fuel from May 1 to October 31 unless gaseous fuel is not available because of a force majeure natural gas curtailment

SMAQMD

- Sacramento Metropolitan AQMD Rule 411 (NOx from Boilers, Process Heaters, and Steam Generators) (Amended August 23, 2007)

[49] Approval and Disapproval of California Air Plan; San Joaquin Valley Serious Are Plan and Attainment Date Extension for the 1997 PM2.5 NAAQS. Final Rule. 81 Fed. Reg. 26, pp. 6936-6986. (2016, February 9) (to be codified at 40 CFR Parts 52 and 81) https://www.gpo.gov/fdsys/pkg/FR-2016-02-09/pdf/2016-02325.pdf and http://www.calbiomass.org/facilities-map/

For biomass units, the District Rule 4352 NOx limit is more stringent than SMAQMD Rule 411. While SMAQMD Rule 411 includes a 40 ppm NOx @ 3% O_2 limit for non-gaseous fired units that may be more stringent than the District's Rule 4352 limits for non-biomass fired units, the non-biomass fired units in the District are used by electric utilities to generate electricity, which is a category that is exempt from SMAQMD Rule 411 requirements. Therefore, the District found no requirements that were more stringent than those already required by District Rule 4352 for the categories of solid-fuel fired units located in the Valley.

	SJVAPCD	SMAQMD
Applicability	NOx emission limit is applicable to any boiler, steam generator or process heater fired on solid fuel	Boilers, steam generators, and process heaters ≥ 1 MMBtu/hr rated heat input capacity
Exemption	Stationary Source that has a potential to emit < 10 tpy of NOx	Unit used by electric utility to generate electricity and waste heat recovery
Requirements Emission Limits	Municipal Solid Waste ≤ 165 ppmv NOx corrected to 12% CO_2 Biomass ≤ 90 ppmv NOx corrected to 3% O_2 All others ≤ 65 ppmv NOx corrected to 3% O_2	Non-gaseous: ≤ 40 ppmv NOx corrected to 3% O_2 Biomass ≤ 70 ppmv corrected to 12% CO_2 (Equivalent to 99 ppmv corrected to 3% O_2)

Yolo Solano AQMD

- YSAQMD Rule 2-43 (Biomass Boilers) (Amended November 10, 2010)

The District evaluated the requirements contained within YSAQMD Rule 2-43 and found no requirements to be more stringent than those already in District Rule 4352.

	SJVAPCD	YSAQMD
Applicability	NOx emission limit is applicable to any boiler, steam generator or process heater fired on solid fuel	Boilers and steam generators with rated heat input of ≥ 5 MMBtu/hr used with biomass fuel

Exemption	Stationary Source that has a potential to emit < 10 tpy of NOx	Combustion units primarily used to burn municipal solid waste.
Requirements Emission Limits, corrected at 3% O_2	Municipal Solid Waste ≤ 165 ppmv NOx corrected to 12% CO_2 Biomass ≤ 90 ppmv NOx corrected to 3% O_2 All others ≤ 65 ppmv NOx corrected to 3% O_2	Biomass ≤ 90 ppmv corrected to 3% O_2

Eldorado County APCD

- ECAPCD Rule 232 (Biomass Boilers) (Amended September 25, 2001)

The District evaluated the requirements contained within EDCAPCD Rule 232 and found no requirements to be more stringent than those already in District Rule 4352.

	SJVAPCD	EDCAPCD
Applicability	NOx emission limit is applicable to any boiler, steam generator or process heater fired on solid fuel	Boilers and steam generators with rated heat input of ≥ 5 MMBtu/hr that have a primary energy source of biomass that consist of a minimum of 75% of the total annual heat input
Exemption	Stationary Source that has a potential to emit < 10 tpy of NOx	Combustion units primarily used to burn municipal solid waste.
Requirements	Municipal Solid Waste ≤ 165 ppmv NOx corrected to 12% CO_2 Biomass ≤ 90 ppmv NOx corrected to 3% O_2 All others ≤ 65 ppmv NOx corrected to 3% O_2	Biomass ≤ 115 ppmv NOx corrected to 12% CO_2 (equivalent to 163 ppmv NOx corrected to 3% O_2)

Placer County APCD

- PCAPCD Rule 233 (Biomass Boilers) (Amended June 14, 2012)

The District evaluated the requirements contained within PCAPCD Rule 233 and found no requirements to be more stringent than those already in District Rule 4352.

	SJVAPCD R4352	PCAPCD R233
Applicability	NOx emission limit is applicable to any boiler, steam generator or process heater fired on solid fuel	Stoker and circulating fluidized bed boilers and steam generators with rated heat input of < 500 MMBtu/hr a potential to emit 25 tons of NOx emissions in which have a primary energy source of biomass consisting of a minimum of 75% of the total annual heat input
Exemption	Stationary Source that has a potential to emit < 10 tpy of NOx	Combustion units primarily used to burn municipal solid waste.
Requirements	<u>Municipal Solid Waste</u> ≤ 165 ppmv NOx corrected to 12% CO_2 <u>Biomass</u> ≤ 90 ppmv NOx corrected to 3% O_2 <u>All others</u> ≤ 65 ppmv NOx corrected to 3% O_2	<u>Biomass Units less than 500 MMBtu/hr</u> ≤ 68 ppmv NOx corrected to 12% CO_2 (equivalent to 96 ppmv NOx corrected to 3% O_2) <u>Biomass Units greater than 500 MMBtu/hr</u> ≤ 115 ppmv NOx corrected to 12% CO_2 (Equivalent to 163 ppm NOx corrected to 3% O_2)

The District evaluated the requirements contained within PCAPCD Rule 233 and found no requirements to be more stringent than those already in District Rule 4352.

Additional Emission Reduction Opportunities

Municipal Solid Waste

<u>Current Status of Municipal Solid Waste Facilities in the Valley</u>

One facility in the Valley operates two Municipal Solid Waste-fired units in the Valley. Each unit is equipped with a baghouse for PM10 control, a dry lime scrubber for SOx control, and a selective non-catalytic reduction system for NOx control.

<u>Potential NOx Control Technologies</u>

MSW facilities nationwide are generally equipped with Selective Non-Catalytic Reduction (SNCR) and utilize this technology to meet emission limits ranging between

165 ppmv corrected to 12% CO_2 to 210 ppmv corrected to 12% CO_2. The District identified the following NOx control technologies that can achieve lower emission rates.

Selective Catalytic Reduction (SCR) is an add-on control system that may be used to reduce NOx emissions from MSW-fired units. SCR systems reduce NOx emissions by converting the emissions to water and elemental nitrogen in the presence of a catalyst. While no SCR retrofits of MSW-fired units were identified in the U.S., several European MSW-fired plants have been retrofitted with selective catalytic reduction systems. For example, Acegas in Padova Italy retrofitted two municipal solid waste units with a selective catalytic reduction system, achieving a permitted NOx limit of 50 ppmv corrected to 7% O_2 (equivalent to 47 ppmv NOx @ 12% CO_2). While sometimes possible, retrofits of MSW-fired units with selective catalytic reduction systems can be infeasible since the retrofit often requires major changes to existing building structures, results in lost revenue due to extensive down-time of the MSW unit, and requires new natural gas pipelines be installed to provide supplemental fuel for required auxiliary burners.

In addition to conventional SCR, Gore & Associates Inc. manufactures DeNOx filter bags that include a catalytic insert for the reduction of NOx emissions from MSW plants. Installation of the Gore De-NOx filter bags simply requires removing the filter bags in the existing baghouse serving the MSW unit and replacing them with Gore De-NOx filter bags that include the catalytic insert. The catalytic insert reduces NOx emissions in the same manner that an SCR catalyst reduces NOx emissions. According to the manufacturer, nine units in Europe have been retrofitted with Gore De-NOx systems and the typical guaranteed NOx emission level for units with this system is 60 ppmv corrected to 7% O_2 (equivalent to 57 ppmv NOx corrected to 12% CO_2). Unlike installations of conventional SCR, Gore De-NOx retrofits do not require extensive building modifications and do not result in significant downtime of the MSW unit. However, the Gore De-NOx system does have several limitations. First, the system requires the baghouse inlet temperature be maintained within a tight operating range of 180 °C to 230 °C. In some instances, facilities can control their temperature to be within this range by adjusting the dilution water flow to the dry lime scrubbers. Secondly, the catalytic filters are only guaranteed by the manufacturer for three years and must be replaced periodically. Finally and most importantly, SOx emissions at the baghouse inlet cannot exceed 10 ppmv corrected to 7% O_2; otherwise ammonia sulfate and ammonium disulfate can form and poison the catalytic filter inserts. In practice, maintaining such low SOx levels requires the operator to vigilantly inspect and remove construction debris from the municipal solid waste fuel. Specifically, gypsum-containing drywall is known to cause spikes in SOx emissions when combusted in MSW plants.

Additional control technologies for MSW plants were identified. In partnership with Martin GMBH of Germany, Covanta Inc. has developed two proprietary NOx control systems for reducing NOx emissions from MSW-fired units. The first technology, known as VLN^{TM}, uses a unique combustion system design which, in addition to conventional primary and secondary air systems, features a new internal stream of “VLN^{TM}-gas” which is drawn from the combustor and re-injected into the furnace. The gas flow distribution between the primary air, secondary air, and VLN^{TM} gas is controlled to yield the optimal flue gas composition and furnace temperature profile to minimize NOx formation and optimize combustion. In conjunction with an optimized SNCR system, VLN^{TM} technology reduces NOx to levels below 60 ppm @ 7% O_2 (equivalent to 57 ppm NOx @ 12% CO_2). However, this system is only available for new units and is not technologically feasible as a retrofit technology.

Covanta Inc. has also developed a simplified version of the VLN^{TM} technology, known as LN^{TM}. This technology was specifically designed for retrofits of existing MSW combustors. Like VLN^{TM}, the LN^{TM} technology adds a stream of "LN^{TM} gas" and optimizes the gas flow distribution between the primary air, secondary air, and the LN^{TM} gas streams to reduce NOx emissions. Unlike VLN^{TM}, LN^{TM} gas is drawn from outside the furnace. In conjunction with an optimized SNCR system, Covanta guarantees NOx emission rates of 110 ppmv corrected to 12% CO_2 on a 24-hour basis and 90 ppmv corrected to 12% CO_2 on a rolling 12-month basis. Covanta LN^{TM} technology has been used at multiple sites within the US. For example, Covanta LN^{TM} technology with an optimized SNCR system is used to reduce NOx emissions from three existing MSW units at the Montgomery County Resource Recovery Facility in Maryland.

<u>Cost Effectiveness of Selective Catalytic Reduction for Municipal Solid Waste Units</u>

The District performed a cost analysis to determine the cost effectiveness of installing a selective catalytic reduction system for a municipal solid waste unit. The District used the following methodology and assumptions for this cost effectiveness analysis:

Assumptions:

- Baseline emission factor is 0.286 lb-NOx/MMBtu (equivalent to 165 ppmv @ 12% CO2)
- SCR provides control to 50 ppmv at 7% O2 (equivalent to 47 ppmv @ 12% CO2)

Cost data was obtained from a preconstruction approval by the Florida Department of Environmental Protection (FDEP) issued on December 23, 2010. The approval was issued for an MSW-fired combustor equipped with SCR for NOx control. The control equipment costs from the FDEP application include uncontrolled NOx emissions of 250 ppmv and controlled NOx emissions of 50 ppmv which represents an 80% reduction in NOx from the SCR. However, 80% reduction from 165 ppmv @ 12% CO2 would yield controlled emissions of 33 ppmv, which is well below BACT. Therefore, controlled emissions are evaluated at the BACT limit of 47 ppmv @ 12% CO2.

The FDEP SCR installation was sized for a unit rated at approximately 460 MMBtu/hr used to produce superheated steam for an electrical generator. The District reviewed the expected exhaust parameters and found them comparable to the parameters for solid fuel-fired boilers in the Valley. Therefore, it is believed that this cost estimate provides a valid basis for estimating costs for installing SCR on MSW-fired boilers in the Valley.

To maximize the emission reductions and economies of scale in estimating the retrofit costs, it is assumed that a 350 MMBtu/hr unit operating at full fire at 100% capacity factor year round for the MSW facility. The purpose of these assumptions is to err on the conservative side throughout the analysis.

Emissions are calculated in the following table:

Table C-1 Emissions from MSW Unit

Fuel	Rating (MMBtu/hr)	Time (hr/yr)	EF (lb/MMBtu)	Emissions (lb/yr)	Emissions (tons/yr)
MSW (baseline)	350	8,760	0.286	876,876	438
MSW (controlled with SCR)	350	8,760	0.081	248,346	124

The capital and operational costs are sized to the facility size using the six-tenths rule, where:

$C_B = C_A \times (S_B \div S_A)^{0.6}$

- CA is a known cost of equipment of size A
- CB is the estimated cost of equipment of size B
- SB is the size of equipment B
- SA is the size of equipment A

It is standard District policy for Best Available Control Technology (BACT) analyses to use a 10 year life and 10% interest rate unless information indicates otherwise; therefore the capital recovery factor (CRF) of 0.1627 will be used to annualize the capital costs.

It is noted that the FDEP cost analysis is for a new unit with an adequately-sized induced draft (ID) fan. However, for a new unit the ductwork can be designed in a way that minimizes pressure losses, allowing for a smaller ID fan than may be required for a retrofit. Affected sources have provided some estimates for additional electrical costs associated with the larger ID fan required for a retrofit, so these have been incorporated into the analysis. In addition, the FDEP analysis is for a new unit so it does not include the loss of revenue from taking a unit off-line to retrofit the new technology. For each unit it is estimated that the retrofit would require at least six months of downtime at $118/MW-hr; this will be added to the capital cost. Finally, the FDEP analysis specifically ignored sales tax on capital equipment on the grounds it is exempt from sales tax in Florida. This would not be the case in California, so 8% sales tax has been included. The cost effectiveness analysis for installing SCR on a MSW unit is as follows:

Table C-2 Cost Effectiveness for Installing SCR on a MSW Unit

Description of Cost	Cost Factor	Cost	Source
Direct Capital Costs (DC):			
Purchase Equipment Costs (PE):			
(A) Basic Equipment:			
1) SCR System (Quote from Babcock Power)		$6,790,099	FDEP[50]
2) Additional Ductwork (220 ft)	$1,800/ft	$336,110	FDEP
3) Increased ID fan size		$7,384	FDEP
Subtotal of Basic Equipment	A	$7,133,593	
(B) Instrumentation and controls: (1% of A)	0.01 A	$71,336	OAQPS
(C) Freight: (5% of A)	0.05 A	$356,680	OAQPS
(D) Taxes	0.08 (A+B+C)	$604,929	OAQPS
PE Total:		$8,166,538	
Direct Installation Costs (DI): Assume Modular SCR w/ simple installation			
Foundation and Supports:	0.16 PE	$1,306,646	OAQPS
Handling and Erection:	0.40 PE	$3,266,615	OAQPS
Electrical: (quote from CH2M Hill)	0.10 PE	$816,654	Industry
Piping: (quote from CH2M Hill)	0.20 PE	$1,633,308	Industry
Insulation:	0.01 PE	$81,665	OAQPS
Painting:	0.01 PE	$81,665	OAQPS
Costs for Expansion of APC Building for SCR Components (quote Malcolm Pirnie)		$366,665	FDEP
DI Total:		$7,553,218	
Retrofit (Deconstruct existing building/structures, estimated equal to DI total)		$7,553,218	District
Natural gas pipeline (replace fuel oil #2) Site Preparation and Buildings		$3,000,000	Industry
DC Total = PE + DI + retrofit + pipeline:		$26,272,974	
Indirect Costs (IC):			
Engineering:	0.10 PE	$816,654	OAQPS
Construction and Field Expenses:	0.05 PE	$408,327	OAQPS
Contractor Fees:	0.10 PE	$816,654	OAQPS
Contingencies:	0.15 PE	$1,224,981	FDEP
Start-up:	0.02 PE	$163,331	OAQPS
Performance Testing:	0.01 PE	$81,665	OAQPS
Retrofit Downtime (6 months minimum, electricity sales and tipping fees)		$11,000,000	Industry
IC Total:		$14,511,612	

50 All costs from FDEP size-adjusted using six-tenths rule from 460 MMBtu/hr to 350 MMBtu/hr.

Description of Cost	Cost Factor	Cost	Source
Total Capital Investments (TCI = DC + IC):		**$40,794,586**	
Direct Annual Costs (DAC):			
Operating Costs (O): (≈ 1,095 shifts/year @ 3 shifts/day)			
Operator: 1.0 hr/shift	$50/hr	$54,750	FDEP
Supervisor:	15% operator	$8,213	OAQPS
Maintenance Costs (M):			
Labor: 1.0 hr/shift	$50/hr	$54,750	FDEP
Material:	100% labor	$54,750	FDEP
Utility Costs (U):			
Performance loss:	$0.08848/kW-hr	$386,495	FDEP
Electricity Cost: (additional 818 kW[51])	$0.08848/kWhr	$634,019	Industry
Catalyst Replace:		$123,071	FDEP
Total DAC:		$1,316,048	
Indirect Annual Costs (IAC):			
Overhead:	60% O & M	$87,828	OAQPS
Insurance:	0.01 TCI	$407,946	OAQPS
Property Tax:	0.01 TCI	$407,946	OAQPS
Administrative:	0.02 TCI	$815,892	OAQPS
Annualized Total Capital Investment:			
interest rate (%) 10			
Period (years): 10	0.1627 TCI	$6,637,279	District Policy
Total IAC:		$9,672,939	
Total Annual Cost (DAC + IAC):		**$9,672,939**	

Table C-3 Summary of Cost Effectiveness for Installing SCR on a MSW Unit

Fuel Type	Baseline Emissions (tons/yr)	Controlled Emissions (tons/yr)	Emissions Reduced (tons/yr)	Adjusted Annualized Cost ($/yr)	Cost Effectiveness ($/ton)
MSW	438	124	314	$9,672,939	**$30,806/ton**

The cost effectiveness for installing SCR on a MSW fired boiler is $30,806 per ton of NOx reduced. It is important to note that this calculation is based off of a new installation of SCR, not a retrofit as would be required by Valley facilities. While some retrofit expenses have been included, operators would incur significant additional costs when retrofitting to incorporate SCR including expenses for additional ductwork, installation of a new natural gas pipeline to replace the existing fuel oil supply, and

[51] Resized from industry estimate of 2 trains, 628 kW/train, for a 715 MMBtu/hr facility, resized to 350 MMBtu/hr

labor; therefore, District staff assumes the cost effectiveness is even higher than presented in this analysis.

Cost Effectiveness of Gore De-NOx for Municipal Solid Waste Units

The District performed a cost analysis to determine the cost effectiveness of Gore De-NOx for a municipal solid waste unit. The District used the following methodology and assumptions for this cost effectiveness analysis:

Assumptions:

- Baseline emission factor is 0.286 lb-NOx/MMBtu (equivalent to 165 ppmv @ 12% CO2)
- Gore De-NOx provides control to 60 ppmv at 7% O2 (equivalent to 57 ppmv @ 12% CO2)
- Capital cost annualized at 10% interest for 10 years
- The Current ID Fan is sufficient for the Gore De-NOx system (per Manufacturer)
- 3-year catalytic insert life (guarantee from manufacturer)
- De-NOx filter replacements will be financed.

Capital cost data was obtained from the manufacturer. To maximize the emission reductions and economies of scale in estimating the retrofit costs, it is assumed that a 350 MMBtu/hr unit operating at full fire at 100% capacity factor year round for the MSW facility. A 350 MMBtu/hr unit is assumed to be equivalent to approximately an 800 ton/day MSW plant. The purpose of these assumptions is to err on the conservative side throughout the analysis.

Emissions are calculated in the following table:

Table C-4 Emissions from a MSW Unit

Fuel	Rating (MMBtu/hr)	Time (hr/yr)	EF (lb/MMBtu)	Emissions (lb/yr)	Emissions (tons/yr)
MSW (baseline)	350	8,760	0.286	876,876	438
MSW (controlled, Gore De-NOx)	350	8,760	0.099	303,534	152

It is standard District policy for Best Available Control Technology (BACT) analyses to use a 10 year life and 10% interest rate unless information indicates otherwise; therefore the capital recovery factor (CRF) of 0.1627 will be used to annualize the capital costs. The cost effectiveness analysis for installing Gore De-NOx on a MSW unit is as follows:

Table C-5 Cost Effectiveness for Installing Gore De-NOx on a MSW Unit

Description of Cost	Cost Factor	Cost	Source
Direct Capital Costs (DC):			

Description of Cost	Cost Factor	Cost	Source
Purchase Equipment Costs (PE):			
(A) Basic Equipment:			
1) Initial Catalytic Filter Bag Installation		$3,224,000	Manufacturer
2) Two Catalytic Filter Bag Replacements during 10 year span.		$6,448,000	Manufacturer
Subtotal of Basic Equipment	A	$9,672,000	
(B) Instrumentation and controls: (1% of A)		0	Manufacturer
(C) Freight: (5% of A)	0.05 A	$483,600	District
(D) Taxes	0.08 (A+B)	$773,760	Local Rate
PE Total:		$10,929,360	
Direct Installation Costs (DI):			
Foundation and Supports:		0	Manufacturer
Handling and Erection:	0.40 PE	$4,371,744	OAQPS
Electrical: (quote from CH2M Hill)		0	Manufacturer
Piping: (quote from CH2M Hill)		0	Manufacturer
Insulation:		0	Manufacturer
Painting:		0	Manufacturer
DI Total:		$4,371,744	
DC Total = PE + DI:		$15,301,104	
Indirect Costs (IC):			
Engineering:	0.10 PE	$1,092,936	OAQPS
Construction and Field Expenses:	0.05 PE	$546,468	OAQPS
Contractor Fees:	0.10 PE	$1,092,936	OAQPS
Contingencies:	0.15 PE	$1,639,404	OAQPS
Start-up:	0.02 PE	$218,587	OAQPS
Performance Testing:	0.01 PE	$109,294	OAQPS
Retrofit Downtime (1 week for initial install and 2 weeks for replacement, electricity sales and tipping fees)		$1,375,000	Based on estimate in 2015 Plan for 1997 PM2.5 Standard
IC Total:		$6,074,625	
Total Capital Investments (TCI = DC + IC):		$21,375,729	
Direct Annual Costs (DAC):			
Operating Costs (O): (≈ 1,095 shifts/year @ 3 shifts/day)			
Operator: 1.0 hr/shift	$50/hr	$54,750	FDEP
Supervisor:	15% operator	$8,213	OAQPS
Maintenance Costs (M):			
Labor: 1.0 hr/shift	$50/hr	$54,750	FDEP

Description of Cost	Cost Factor	Cost	Source
Material:	100% labor	$54,750	OAQPS
Construction Material Sorting Cost: 292,000 tons sorted/year, Based on 800 tons/day @ 365 days/year	$15/ton	$4,380,000	EU Report[52]
Total DAC:		$4,552,463	
Indirect Annual Costs (IAC):			
Overhead:	60% O & M	$87,828	OAQPS
Insurance:	0.01 TCI	$213,757	OAQPS
Property Tax:	0.01 TCI	$213,757	OAQPS
Administrative:	0.02 TCI	$427,515	OAQPS
Annualized Total Capital Investment: interest rate (%) 10			
Period (years): 10	0.1627 TCI	$3,477,831	District Policy
Total IAC:		$4,420,688	
Total Annual Cost (DAC + IAC):		**$8,973,151**	

Table C-2 Summary of Cost Effectiveness for Installing Gore De-NOx on a MSW Unit

Fuel Type	Baseline Emissions (tons/yr)	Controlled Emissions (tons/yr)	Emissions Reduced (tons/yr)	Adjusted Annualized Cost ($/yr)	Cost Effectiveness ($/ton)
MSW	438	152	286	$8,973,151	**$31,375/ton**

Cost Effectiveness of Covanta LN™ for Municipal Solid Waste Units

The District performed a cost analysis to determine the cost effectiveness of Covanta LN™ for a municipal solid waste unit. The District used the following methodology and assumptions for this cost effectiveness analysis:

Assumptions:

- Baseline emission factor is 0.286 lb-NOx/MMBtu (equivalent to 165 ppmv @ 12% CO2)
- LN^TN provides control to 90 ppmv @ 12% CO2, on an annual average (per Covanta)
- Capital cost annualized at 10% interest for 10 years

[52] Source: "Costs for Municipal Waste Management in the EU: Final Report to Directorate General Environment, European Commission" lists a MSW sorting cost range of €14/tonne to €22/tonne, depending on the type of material sorted from the waste. The District conservatively used €14/tonne (equivalent to $15/ton) to estimate the cost to sort construction material from the waste, which is necessary to prevent catalyst poisoning).

Since the Covanta LN™ system is proprietary, capital and operating costs are difficult to obtain directly from the manufacturer. However, the total capital investment and operating costs for an actual; LN™ installation were obtained from the "NOx RACT for Municipal Waste Combustors (MWCs)", a presentation by the Maryland Department of Environment at a stakeholder meeting on January 17, 2017. For three 600 ton/day MSW units, the combined total capital investment for LN™ was approximately $7,500,000 (2017 dollars), or $2,500,000/unit. Per the presentation, the annual combined operating cost was $566,000/year, or about $189,000/unit.

To maximize the emission reductions and economies of scale in estimating the retrofit costs, it is assumed that a 350 MMBtu/hr unit operating at full fire at 100% capacity factor year round for the MSW facility. A 350 MMBtu/hr unit is assumed to be equivalent to approximately an 800 ton/day MSW plant. The purpose of these assumptions is to err on the conservative side throughout the analysis.

The capital and operational costs are sized to the facility size using the six-tenths rule, where:

- CA is a known cost of equipment of size A
- CB is the estimated cost of equipment of size B
- SB is the size of equipment B
- SA is the size of equipment A

$C_B = C_A \times (S_B \div S_A)^{0.6}$

Emissions are calculated in the following table:

Table C-3 Emissions from a MSW Unit

Fuel	Rating (MMBtu/hr)	Time (hr/yr)	EF (lb/MMBtu)	Emissions (lb/yr)	Emissions (tons/yr)
MSW (baseline)	350	8,760	0.286	876,876	438
MSW (controlled, LN™)	350	8,760	0.156	478,296	239

It is standard District policy for Best Available Control Technology (BACT) analyses to use a 10 year life and 10% interest rate unless information indicates otherwise; therefore the capital recovery factor (CRF) of 0.1627 will be used to annualize the capital costs.

The cost effectiveness analysis for installing LN™ on a MSW unit is as follows:

Table C-8 Cost Effectiveness for Installing LN™ on a MSW Unit

Description of Cost	Cost Factor	Cost	Source
Total Capital Investment			
TCI, including 3-months lost revenue for downtime.		$10,300,000	Maryland RACT Presentation[53]
Direct Annual Costs (DAC):			
Total DAC:		225,000	Maryland RACT Presentation[6]
Indirect Annual Costs (IAC):			
Insurance:	0.01 TCI	$103,000	OAQPS
Property Tax:	0.01 TCI	$103,000	OAQPS
Administrative:	0.02 TCI	$206,000	OAQPS
Annualized Total Capital Investment: interest rate (%) 10 Period (years): 10	0.1627 TCI	$1,675,810	District Policy
Total IAC:		$2,087,810	
Total Annual Cost (DAC + IAC):		**$2,312,810**	

Table C-9 Summary of Cost Effectiveness for Installing LN™ on a MSW Unit

Fuel Type	Baseline Emissions (tons/yr)	Controlled Emissions (tons/yr)	Emissions Reduced (tons/yr)	Adjusted Annualized Cost ($/yr)	Cost Effectiveness ($/ton)
MSW	438	239	199	$2,312,810	**$11,622/ton**

In May 2018, the District issued an Authority to Construct to Covanta municipal solid waste combustion operation to implement Covanta LN technology to lower NOx emissions from 165 ppm at 12% CO_2 on a daily average to 110 ppm at 12% CO_2 on a daily average and 90 ppm at 12% CO_2 on an annual average. However, the construction has not started and the feasibility of this technology remains to be demonstrated on a continuous basis. The District will continue to monitor the progress of the implementation of this new technology.

Biomass Facilities

[53] All costs from Maryland RACT Presentation were size-adjusted using six-tenths rule from a 600 tons/day MSW Unit to an 800 ton/day MSW Unit. An additional 7.3 million in lost revenue was added to the adjusted cost from the Maryland RACT presentation. This value was based on an estimated 4-month installation timeline, equivalent to the March through June 2006 timeline for a VLN installation in Bristol Connecticut. The revenue lost was based on a linear adjustment of the revenue losses listed in the 2015 Ozone plan for an MSW plant downtime of 6 months.

Current Status of Biomass Facilities in the Valley and District Exploration of Biomass Alternatives

Historically, the presence of biomass facilities in the Valley has played a vital role in reducing NOx and PM emissions from open burning practices. Until 2014, District restrictions reduced open burning of agricultural waste in the Valley by 80% and much of that waste was diverted to biomass-fired power plants. However, the biomass industry has indicated that given current energy policy in California there is concern that biomass power facilities are in jeopardy. Many biomass plants in the Valley are nearing, or have come to, the end of their long-term contracts with utilities and find themselves in a position where the power that they provide is not the type of power that utilities are seeking (base load vs. intermittent) and that the prices being offered for new contracts are too low to support their operations.

Since 2012, six of the valley's biomass plants have shut down, reducing the valley's biomass power plant capacity by more than 50%. With additional biomass facilities on the brink of closure, it has become even more infeasible to require citrus orchard removals to be sent for use in biomass power plants. At the same time, drought and increase in fallowed land has resulted in an increased need to dispose of agricultural waste. The District anticipates open burning emissions to increase without cost effective alternatives for the disposal of agricultural waste.

The District has convened a number of productive meetings with agricultural stakeholders and representatives of the biomass industry in order to more fully understand the issues faced by the industry and develop a common vision of the future of biomass power amongst the stakeholders in the Valley. The meetings have been helpful in forging a better working relationship between agriculture representatives and biomass power producers and developing consensus on long-term solutions.

In June 2014, the District's Governing Board adopted positions on two pieces of legislation that impact the biomass industry. The District adopted a position in support of AB 2363 (Dahle), which was sponsored by the biomass industry, and would make biomass plants more competitive by fully accounting for the costs associated with intermittent sources of renewable power (solar and wind) when comparing them to other sources of power. AB 2363 was signed by the Governor and will begin to help level the renewable energy playing field. The District also took a position in opposition to SB 1139 (Hueso) that would have given preferential treatment to new geothermal power plants by requiring that utilities purchase specified amounts of new geothermal power. Ultimately, AB 1139 was not passed by the legislature.

On November 14 and 15, 2017, the District hosted the *Central Valley Summit on Alternatives to Open Burning of Agricultural Waste.* In addition to traditional biomass power plants, alternatives to open burning discussed included soil re-incorporation of agricultural waste, composting, conversion of agricultural waste into electrical power or fuels, biochar plants, on-site/portable power production for electrical generation and irrigation well pump power, and air curtain incineration. The district has recently permitted, or is in the process of permitting, permits for several air curtain incinerators and permits for a forest waste gasification/pyrolysis operation that provides syn-gas to two engines for the production of electricity. Additionally, Aemetis has approached the District with a proposal to install a biomass to ethanol plant in Riverbank, and several biochar manufacturers have approached the District with proposals for biochar manufacturing operations. However, traditional biomass power producers continue to play the largest role in reducing the open burning of agricultural waste.

There is consensus that biomass power producers currently are not on a level playing field in competing with other renewable sources of power for utility contracts. They are also not receiving any preferential treatment for the societal benefits for providing a cleaner alternative to the open burning of agricultural waste and assisting with meeting landfill diversion goals. Contracts between power producers and utilities are confidential, but the current market rate that the biomass plants can garner is approximately 6 cents/KWH. This is the rate that the utilities obtain through contracts with solar power providers. This low cost is made possible largely due to government subsidies provided for solar power production. Biomass power producers have indicated that it takes approximately 9-10 cents/KWH for the plants to cover their operating costs.

The District and representatives from agriculture and biomass industries are working to develop and pursue specific actions with the legislative branch, utilities, Public Utility Commission, CalRecycle, and other government agencies to help level the playing field and allow the biomass industry to fairly compete. The District will also continue to work with the stakeholders including the Federal Department of Energy, California Energy Commission, and other partner agencies to pursue clean alternatives to biomass power production for agricultural waste disposal.

Potential Control Technologies to Reduce NOx emissions from Biomass-fired Units

Most existing Biomass fired power plants in the Valley control NOx using selective non-catalytic reduction (SNCR), also referred to as ammonia injection. NOx emission limits for biomass power plants controlled with SNCR systems range from 0.08 lb-NOx/MMBtu to 0.1 lb-NOx/MMBtu (daily average). The current rule 4352 limits NOx emissions from biomass-fired boilers to 90 ppm @ 3% O_2 (equivalent to 0.12 lb/MMBtu using an F-Factor of 9420 dscf/MMBtu).

Selective Catalytic Reduction (SCR) add-on control systems are considered BACT for biomass-fired power plants. SCR systems reduce NOx emissions by converting the emissions to water and elemental nitrogen in the presence of a catalyst. One known issue with the use of SCR systems on biomass-fired power plants is catalyst poisoning and subsequent catalyst activity reduction. In particular, catalyst poisoning by alkali metals is an issue that is unique for biomass-fired plants that are equipped with SCR catalysts. To reduce the potential for catalyst poisoning by alkali metals, SCR systems for biomass-fired units are nearly always tail-end systems, where the SCR catalyst is located downstream of a particulate matter control device. Additionally, wet flue-gas desulfurization systems may be used after the particulate matter control device and prior to the SCR inlet to further reduce the quantity of ash and soluble alkali metals from reaching and poisoning the SCR catalyst. Biomass plants with Selective Catalytic Reduction typically are able to achieve emission rates of 0.065 lb-NOx/MMBtu (daily average), which is just under 50 ppmvd @ 3% O_2.

Cost Effectiveness of Selective Catalytic Reduction for Biomass Plants

As mentioned earlier, most existing facilities in the valley are equipped with SNCR and although it appears that facilities could possibly achieve a lower NOx limit beyond the revised proposed rule amendments, additional NOx control technology such as SCR would be needed. In fact, the installations that are achieving lower NOx emissions are typically installed as new installations equipped with the SCR technology, with one exception. One facility in the Valley has installed SCR on a smaller existing boiler under an experimental research exemption approved in February 2008. In March 2009, the District approved the facility's application to replace the existing SNCR (which had become inoperable) with the SCR installed under the experimental research exemption. This modification did not result in any reduction in permitted emissions as the SCR-equipped boiler is only required to comply with the same emission limit the SNCR-equipped boiler was. This modification was incorporated into the Title V permit in September 2010. While this example may indicate that SCR is technologically feasible as a retrofit for smaller sized biomass-fired boilers, there are many other considerations unique to each facility that may inhibit the retrofit of a SCR system. It is important to note that this cost effectiveness analysis does not take into consideration the current economic struggles of the biomass industry, as previously described.

The District used the following methodology and assumptions for this cost effectiveness analysis:

Assumptions

- Baseline emission factor is 0.11 lb-NOx/MMBtu for Biomass (equivalent to 85ppmv @ 3% O2)
- SCR reduces NOx emissions to 0.004 lb-NOx/MMBtu (annual average, based on review of annual CEMS data for a permitted biomass unit with SCR)
- Capital cost annualized at 10% interest for 10 years

Cost data was obtained from a preconstruction approval by the FDEP issued on December 23, 2010, as described above in the MSW section.

To maximize the emission reductions and economies of scale in estimating the retrofit costs, it is assumed that a 350 MMBtu/hr unit is operating at full fire at 100% capacity factor year round is representative for the Valley biomass facilities. The purpose of these assumptions is to err on the conservative side throughout the analysis.

Table C-10 Emissions from a Biomass Unit

Fuel	Rating (MMBtu/hr)	Time (hr/yr)	EF (lb/MMBtu)	Emissions (lb/yr)	Emissions (tons/yr)
Biomass (baseline)	350	8,760	0.11	337,260	169
Biomass (controlled, SCR)	350	8,760	0.04	122,640	61

It is standard District policy for Best Available Control Technology (BACT) analyses to use a 10 year life and 10% interest rate unless information indicates otherwise; therefore the capital recovery factor (CRF) of 0.1627 will be used to annualize the capital costs.

The cost effectiveness analysis for installing SCR on a biomass unit is as follows:

Table C-4 Cost Effectiveness for Installing SCR on a Biomass Unit

Description of Cost	Cost Factor	Cost	Source
Direct Capital Costs (DC):			
Purchase Equipment Costs (PE):			
(A) Basic Equipment:			
1) SCR System (Quote from Babcock Power)		$6,790,099	FDEP[54]
2) Additional Ductwork (220 ft)	$1,800/ft	$336,110	FDEP
3) Increased ID fan size		$7,384	FDEP
Subtotal of Basic Equipment	A	$7,133,593	
(B) Instrumentation and controls: (1% of A)	0.01 A	$71,336	OAQPS
(C) Freight: (5% of A)	0.05 A	$356,680	OAQPS
(D) Taxes	0.08 (A+B+C)	$604,929	OAQPS
PE Total:		$8,166,538	
Direct Installation Costs (DI): Assume Modular SCR w/ simple installation			
Foundation and Supports:	0.16 PE	$1,306,646	OAQPS
Handling and Erection:	0.40 PE	$3,266,615	OAQPS
Electrical: (quote from CH2M Hill)	0.10 PE	$816,654	Industry
Piping: (quote from CH2M Hill)	0.20 PE	$1,633,308	Industry
Insulation:	0.01 PE	$81,665	OAQPS
Painting:	0.01 PE	$81,665	OAQPS
DI Total:		$7,186,553	
DC Total = PE + DI		$15,353,091	
Indirect Costs (IC):			

[54] All costs from FDEP size-adjusted using six-tenths rule from 460 MMBtu/hr to 350 MMBtu/hr.

Description of Cost	Cost Factor	Cost	Source
Engineering:	0.10 PE	$1,535,309	OAQPS
Construction and Field Expenses:	0.05 PE	$767,655	OAQPS
Contractor Fees:	0.10 PE	$1,535,309	OAQPS
Contingencies:	0.15 PE	$2,302,964	FDEP
Start-up:	0.02 PE	$307,062	OAQPS
Performance Testing:	0.01 PE	$153,531	OAQPS
IC Total:		$6,601,829	
Total Capital Investments (TCI = DC + IC):		$21,954,920	
Direct Annual Costs (DAC): Assume SCR requires 0.5 hrs/shift			
Operating Costs (O): (≈ 1,095 shifts/year @ 3 shifts/day)			
Operator: 1.0 hr/shift	$50/hr	$54,750	FDEP
Supervisor:	15% operator	$8,213	OAQPS
Maintenance Costs (M):			
Labor: 1.0 hr/shift	$50/hr	$54,750	FDEP
Material:	100% labor	$54,750	FDEP
Utility Costs (U):			
Performance loss:	$0.08848/kW-hr	$386,495	FDEP
Electricity Cost: (additional 818 kW[55])	$0.08848/kWhr	$634,019	Industry
Catalyst Replace:		$123,071	FDEP
Total DAC:		$1,316,048	
Indirect Annual Costs (IAC):			
Overhead:	60% O & M	$87,828	OAQPS
Insurance:	0.01 TCI	$219,549	OAQPS
Property Tax:	0.01 TCI	$219,549	OAQPS
Administrative:	0.02 TCI	$439,098	OAQPS
Annualized Total Capital Investment: interest rate (%) 10			
Period (years): 10	0.1627 TCI	$3,572,065	District Policy
Total IAC:		$4,538,089	
Total Annual Cost (DAC + IAC):		**$5,854,137**	

Emissions are calculated in the following table:

Table C-5 Summary of Cost Effectiveness for installing SCR on a Biomass Unit

Fuel Type	Baseline Emissions (tons/yr)	Controlled Emissions (tons/yr)	Emissions Reduced (tons/yr)	Adjusted Annualized Cost ($/yr)	Cost Effectiveness ($/ton)

[55] Resized from industry estimate of 2 trains, 628 kW/train, for a 715 MMBtu/hr facility, resized to 350 MMBtu/hr

Biomass	169	61	108	5,854,137	**$54,205/ton**

Other Solid Fuels

Current Status of Other Solid Fuel Fired Units in the Valley

One facility in the Valley operates a unit that is permitted to fire on coal/biomass; however, the unit has only been fired on biomass since 2013. This facility is equipped with a baghouse for PM10 control, dry lime injection for SOx control, and a selective non-catalytic reduction system for NOx control.

Potential NOx Control Technologies for Other Solid Fuel Fired Units

Other solid fuel fired facilities are generally equipped with Selective Non-Catalytic Reduction (SNCR) and utilize this technology to meet emission the Rule 4352 emission limit of 65 ppmv @ 3% O_2. Selective Catalytic Reduction (SCR) is an add-on control system that may be used to reduce NOx emissions from other solid fuel fired units. SCR systems reduce NOx emissions by converting the emissions to water and elemental nitrogen in the presence of a catalyst. Using SCR, other solid fuel fired units would be expected to achieve emission rates at low as 0.04 lb-NOx/MMBtu on an annual average. The District used the following methodology and assumptions for this cost effectiveness analysis:

Assumptions

- Baseline emission factor is 0.09 lb-NOx/MMBtu coal/petcoke/other fuels (equivalent to 65ppmv @ 3% O2)
- SCR reduces NOx emissions to 0.04 lb-NOx/MMBtu (annual average, based on review of annual CEMS data for a permitted biomass unit with SCR)
- Capital cost annualized at 10% interest for 10 years

Cost data was obtained from a preconstruction approval by the FDEP issued on December 23, 2010 as described above in the MSW section.

To maximize the emission reductions and economies of scale in estimating the retrofit costs, it is assumed that a 350 MMBtu/hr unit is operating at full fire at 100% capacity factor year round is representative for the Valley solid-fired fuel facilities. The purpose of these assumptions is to err on the conservative side throughout the analysis.

Table C-6 Emissions from an Other Solid Fuel Fired Unit

Fuel	Rating (MMBtu/hr)	Time (hr/yr)	EF (lb/MMBtu)	Emissions (lb/yr)	Emissions (tons/yr)
Other(baseline)	350	8,760	0.09	275,940	138
Other (controlled, SCR)	350	8,760	0.04	122,640	61

It is standard District policy for Best Available Control Technology (BACT) analyses to use a 10 year life and 10% interest rate unless information indicates otherwise; therefore the capital recovery factor (CRF) of 0.1627 will be used to annualize the capital costs. The cost effectiveness analysis for installing SCR on an other solid fuel fired unit is as follows:

Table C-7 Cost Effectiveness for Installing SCR on Other Solid Fired Fuel Unit

Description of Cost	Cost Factor	Cost	Source
Direct Capital Costs (DC):			
Purchase Equipment Costs (PE):			
(A) Basic Equipment:			
4) SCR System (Quote from Babcock Power)		$6,790,099	FDEP[56]
5) Additional Ductwork (220 ft)	$1,800/ft	$336,110	FDEP
6) Increased ID fan size		$7,384	FDEP
Subtotal of Basic Equipment	A	$7,133,593	
(B) Instrumentation and controls: (1% of A)	0.01 A	$71,336	OAQPS
(C) Freight: (5% of A)	0.05 A	$356,680	OAQPS
(D) Taxes	0.08 (A+B+C)	$604,929	OAQPS
PE Total:		$8,166,538	
Direct Installation Costs (DI): Assume Modular SCR w/ simple installation			
Foundation and Supports:	0.16 PE	$1,306,646	OAQPS
Handling and Erection:	0.40 PE	$3,266,615	OAQPS
Electrical: (quote from CH2M Hill)	0.10 PE	$816,654	Industry
Piping: (quote from CH2M Hill)	0.20 PE	$1,633,308	Industry
Insulation:	0.01 PE	$81,665	OAQPS
Painting:	0.01 PE	$81,665	OAQPS
DI Total:		$7,186,553	
DC Total = PE + DI		$15,353,091	
Indirect Costs (IC):			
Engineering:	0.10 PE	$1,535,309	OAQPS
Construction and Field Expenses:	0.05 PE	$767,655	OAQPS
Contractor Fees:	0.10 PE	$1,535,309	OAQPS
Contingencies:	0.15 PE	$2,302,964	FDEP
Start-up:	0.02 PE	$307,062	OAQPS
Performance Testing:	0.01 PE	$153,531	OAQPS
IC Total:		$6,601,829	
Total Capital Investments (TCI = DC + IC):		$21,954,920	
Direct Annual Costs (DAC): Assume SCR requires 0.5 hrs/shift			
Operating Costs (O): (≈ 1,095 shifts/year @ 3 shifts/day)			

[56] All costs from FDEP size-adjusted using six-tenths rule from 460 MMBtu/hr to 350 MMBtu/hr.

Description of Cost	Cost Factor	Cost	Source
Operator: 1.0 hr/shift	$50/hr	$54,750	FDEP
Supervisor:	15% operator	$8,213	OAQPS
Maintenance Costs (M):			
Labor: 1.0 hr/shift	$50/hr	$54,750	FDEP
Material:	100% labor	$54,750	FDEP
Utility Costs (U):			
Performance loss:	$0.08848/kW-hr	$386,495	FDEP
Electricity Cost: (additional 818 kW[57])	$0.08848/kWhr	$634,019	Industry
Catalyst Replace:		$123,071	FDEP
Total DAC:		$1,316,048	
Indirect Annual Costs (IAC):			
Overhead:	60% O & M	$87,828	OAQPS
Insurance:	0.01 TCI	$219,549	OAQPS
Property Tax:	0.01 TCI	$219,549	OAQPS
Administrative:	0.02 TCI	$439,098	OAQPS
Annualized Total Capital Investment: interest rate (%) 10			
Period (years): 10	0.1627 TCI	$3,572,065	District Policy
Total IAC:		$4,538,089	
Total Annual Cost (DAC + IAC):		**$5,854,137**	

Table C-8 Summary of Cost Effectiveness for installing SCR on Other Solid Fuel Fired Unit

Fuel Type	Baseline Emissions (tons/yr)	Controlled Emissions (tons/yr)	Emissions Reduced (tons/yr)	Adjusted Annualized Cost ($/yr)	Cost Effectiveness ($/ton)
Other	138	61	77	5,854,137	**$76,028/ton**

Controls for Direct PM2.5 Emissions from All Unit Types

The District researched the potential opportunity of specifying required controls for direct PM2.5 emissions. Three technologies were recognized as being able to potentially reduce direct PM2.5 emissions: electrostatic precipitators (ESPs), baghouses, and cyclones.

An ESP is a particulate collection device that removes particles from a flowing gas using the force of an electrostatic charge with a 90- 99.9% control efficiency of PM2.5 for solid

[57] Resized from industry estimate of 2 trains, 628 kW/train, for a 715 MMBtu/hr facility, resized to 350 MMBtu/hr

fuel fired boilers within the 100-500 MMBtu/hr size range of District units.[58] A baghouse, on the other hand, is a technology in which particulates are removed from a stream of exhaust gases as the stream passes through a large cloth bag. Baghouses have a PM2.5 removal effectiveness of 90-99.9% for solid fuel fired boilers in the size range of District units.[59] Coal and coke-fired units generally use baghouses, but biomass boilers usually use ESPs because of the health and safety risk of the burning embers causing a fire in the baghouse. However, when cyclones are combined with the use of a baghouse, the burning embers are extinguished and allow for the use of a baghouse in a biomass facility[60]. This also reduces acid gases and some PM2.5 compared to the use of a baghouse alone.

All of the facilities subject to Rule 4352 have installed either a baghouse or ESP particulate matter removal system due to permitting requirements. Since the control efficiency ranges for both technologies are equivalent, there are currently no other PM controls more effective than current practices.

Start-up Periods

The possibility of reducing the allowed start-up period of solid fuel fired boilers was considered, since facilities are exempt from emissions limits during this period. Facilities subject to Rule 4352 are currently subject to a start-up limit of 96 hours. Operators currently limit their start-up and shut-down times as much as possible since down time results in reduced productivity and profits. However, facilities periodically perform “cold repairs” on their solid fuel fired boilers for maintenance or trouble-shooting purposes. This requires operators to completely shut down the boilers, which in turn requires a longer start-up period to return to correct operating temperature. When the solid fuel fired boilers are starting up, the units are not operating with a full load which reduces emissions. Therefore, this is not a technologically feasible option for solid fuel fired facilities given the needs of current work practices.

EVALUATION FINDINGS

Municipal Waste-Fired Units

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this category. As demonstrated above, Rule 4352 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds both BACM and MSM requirements for this source category. The District’s evaluation of potential control technologies has found that the Gore De-NOx and Selective Catalytic Reduction technologies demonstrated in Europe are extremely costly, require

[58] Senior, C., Afonso, R. (January 2009). *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Northeast States for Coordinated Air Use Management.
[59] Senior, C., Afonso, R. (January 2009). *Applicability and Feasibility of NOx, SO2, and PM Emissions Control Technologies for Industrial, Commercial, and Institutional (ICI) Boilers.* Northeast States for Coordinated Air Use Management.
[60] Roberts, C. (2009). *Information on Air Pollution Control Technology for Woody Biomass Boilers.* Northeast States for Coordinated Air Use Management and the EPA Office of Air Quality Planning and Standards.

additional evaluation for feasibility, and are overall economically infeasible in this sector. The District's evaluation of the Covanta LN NOx technology has found that, while costly, installation of this technology may be cost-effective. While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will pursue the following potential opportunities to reduce NOx emissions for municipal waste-fired units to the extent that additional NOx controls are technologically and economically feasible:

- Lower NOx limit from 165 ppmv @ 12% CO_2 to 110 ppmv @ 12% CO_2 over 24-hr period and 90 ppmv @ 12% CO_2 over annual period
- Evaluate feasibility of lower NOx emission levels

Biomass-Fired Units

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this category. As demonstrated above, Rule 4352 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds both BACM and MSM requirements for this source category.

The proposed commitments by the District and CARB will each achieve an aggregate emission reduction of direct PM2.5 and NOx. While the commitments include estimates of the emission reductions from each individual measure, final measures as proposed for adoption into the state implementation plan (SIP) may provide more or less emission reductions. The aggregate commitment will guarantee that the total emission reductions will be achieved to attain each NAAQS as expeditiously as practicable.

C.14 Rule 4354 (Emissions from Glass Melting Furnaces)

Discussion

The provisions of Rule 4354 are applicable to glass melting furnaces in the San Joaquin Valley. The purpose of this rule is to limit nitrogen oxides (NOx), sulfur oxides (SOx), volatile organic compounds (VOC), carbon monoxide (CO), and particulate matter (PM_{10}) emissions from glass melting furnaces.

Rule 4354 was adopted on September 14, 1994, and has been subsequently amended six times. EPA finalized approval of the most recent amendments to Rule 4354 on January 31, 2013, and deemed this rule as being as stringent as, if not more stringent than, established RACT requirements. As a result of this stringent prohibitory rule and continuing efforts on behalf of this industry to reduce emissions, the Valley is home to six glass-making facilities with glass melting furnaces that utilize the most advanced low-NOx firing technology. The NOx emission limits contained within Rule 4354 require the installation of the best available NOx technology (i.e. oxy-fuel firing or SCR systems).

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.34	0.17	0.18	0.18	0.19	0.20	0.20	0.20	0.20
NOx	6.21	3.20	3.30	3.32	3.41	3.50	3.50	3.50	3.50
	Winter Average - Tons per day								
PM2.5	0.34	0.17	0.18	0.18	0.19	0.20	0.20	0.20	0.20
NOx	6.21	3.20	3.30	3.32	3.41	3.50	3.50	3.50	3.50

Source Category

Industrial glass making is a continuous process with raw materials supplied to the furnace at the front end, and product taken off the line at the back end of the process. The raw materials for making glass are silica sand and soda ash. Melting these basic materials and forming them into the desired product geometry creates the final glass product. The different end products vary widely in raw material additives, processing equipment and conditions, and product quality requirements. The emission limits of Rule 4354 depend on the type of glass produced, furnace firing technology and the emission-averaging period.

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

Federal Regulations

There are no EPA CTG requirements for this source category

Alternative Control Techniques (ACT)

- EPA-453/R-94-37 - NOx Emissions from Glass Manufacturing (June 1994)

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

New Source Performance Standards (NSPS)

- 40 CFR 60 Subpart CC - Standards of Performance for Glass Manufacturing Plants (Amended October 17, 2000)

40 CFR 60 Subpart CC was last amended on October 17, 2000. However, this subpart only applies to glass melting furnaces that commenced construction or modification after June 15, 1979. All of the glass melting furnaces currently located within the District commenced construction prior to June 15, 1979 and have not been modified (as defined in subpart CC) since that time. Therefore, none of the glass plants located within the District are subject to the requirements of Subpart CC and its requirements have not been included as a part of this control measure source category evaluation.

- 40 CFR 60 Subpart PPP - Standards of Performance for Wool Fiberglass Manufacturing Plants (Amended October 17, 2000)

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

National Emissions Standards for Hazardous Air Pollutants (NESHAP)/Maximum Achievable Control Technology (MACT)

- 40 CFR 61 Subpart N – National Emission Standard for Inorganic Arsenic Emissions from Glass Manufacturing Plants

40 CFR 61 Subpart N was last amended on February 27, 2014; however, this NESHAP only regulates inorganic arsenic emissions and therefore does not apply to this control measure source category evaluation.

- 40 CFR 63 Subpart NN – National Emission Standards for Hazardous Air Pollutants for Wool Fiberglass Manufacturing at Area Sources

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

- 40 CFR 63 Subpart NNN – National Emission Standards for Hazardous Air Pollutants for Wool Fiberglass Manufacturing

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

- 40 CFR 63 Subpart HHHH – National Emission Standards for Hazardous Air Pollutants for Wet-Formed Fiberglass Mat Production

40 CFR 63 Subpart HHHH was last amended on April 20, 2006; however, this NESHAP only contains emission limits and regulations to reduce formaldehyde emissions. Formaldehyde is an organic compound which is most closely related to VOC emissions. This control measure analysis does not apply to VOC emissions. Therefore, the requirements of Subpart HHHH have not been included as a part of this control measure source category evaluation.

- 40 CFR 63 Subpart SSSSSS – National Emission Standards for Hazardous Air Pollutants for Glass Manufacturing Area Sources

The District evaluated the requirements contained within Subpart SSSSSS 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?
There are no analogous rules for this source category in SMAQMD and VCAPCD

SCAQMD
- SCAQMD Rule 1117 (Emissions of Oxides of Nitrogen from Glass Melting Furnaces) *(Amended January 6, 1984)*

The District evaluated the control requirements in SCAQMD Rule 1117, and found no requirements that were more stringent than those already in Rule 4354.

	SJVAPCD	SCAQMD
Applicability	The provisions of this rule shall apply to any glass melting furnaces for the production of, container glass, fiberglass, and flat glass	This rule limits the emission of nitrogen oxides (NOx) from glass melting furnaces.
Exemption	• Electric furnaces which all heat is provided by electric current from electrodes. • Any glass melting furnace that is part of a stationary source with a total potential to emit for all processes, less than 10.0 tons/yr of NOx and less than 10.0 tons/yr of VOC. • A unit that meets all of the following criteria is not subject to the PM_{10} emission limits or the PM_{10} monitoring requirements of the rule:	• Furnaces which are limited by Permit to operate to 15 lbs/hour of NOx or less. • 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 glass tableware exclusively. • Flat glass melting furnaces.

	- Furnace has permitted glass production capacity less 5 tons/day. - Total actual NO_X emissions for a facility less than 8 tons/year. - Total actual VOC emissions for a facility less than 8 tons/year.		• Furnaces used in the melting of glass for the production of fiberglass exclusively. • Idling furnaces.
Requirements	The operator of any glass melting furnace shall not operate a furnace in such a manner that results in NO_X or PM_{10} emissions exceeding the following limits:		After December 31, 1992, no person shall operate a furnace capable of discharging NO_X into the atmosphere unless such discharge of NO_X in to the atmosphere is limited to the following:
	Container Glass:		
	NO_X	1.5 lb/ton[B]	4.0 lb/ton[A]
	PM_{10}	0.50 lb/ton[A]	No Limit Specified
	Fiberglass:		
	NO_X	1.3 lb/ton[A, C] 3.0 lb/ton[A, D]	No Limit Specified, Exempt
	PM_{10}	0.50 lb/ton[A]	No Limit Specified, Exempt
	Flat Glass:		
	NO_X Standard Option	3.7 lb/ton[A] 3.2 lb/ton[B]	No Limit Specified, Exempt
	NO_X Enhanced Option	3.4 lb/ton[A] 2.9 lb/ton[B]	
	PM_{10}	0.70 lb/ton[A]	No Limit Specified, Exempt

[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

BAAQMD

- BAAQMD Regulation 9 Rule 12 (Nitrogen Oxide Emissions from Glass Melting Furnaces) *(Adopted January 19, 1994)*

The District evaluated the control requirements in BAAQMD Rule 9-12, and found no requirements that were more stringent than those already in Rule 4354.

<table>
<tr><th></th><th colspan="2">SJVAPCD</th><th>BAAQMD</th></tr>
<tr><td>Applicability</td><td colspan="2">The provisions of this rule shall apply to any glass melting furnaces for the production of, container glass, fiberglass, and flat glass</td><td>This rule limits the emission of nitrogen oxides (NOx) from glass melting furnaces.</td></tr>
<tr><td>Exemption</td><td colspan="2">• Electric furnaces which all heat is provided by electric current from electrodes.
• Any glass melting furnace that is part of a stationary source with a total potential to emit for all processes, less than 10.0 tons/yr of NOx and less than 10.0 tons/yr of VOC.
• A unit that meets all of the following criteria is not subject to the PM_{10} emission limits or the PM_{10} monitoring requirements of the rule:
- Furnace has permitted glass production capacity less 5 tons/day.
- Total actual NO_X emissions for a facility less than 8 tons/year
- Total actual VOC. emissions for a facility less than 8 tons/year.</td><td>• Electric furnaces which all heat is provided by electric current from electrodes.
• Furnaces with a production capacity of 4550 kg (5 short tons) of glass per day or less.</td></tr>
<tr><td rowspan="4">Requirements</td><td colspan="2">The operator of any glass melting furnace shall not operate a furnace in such a manner that results in NO_X or PM_{10} emissions exceeding the following limits:</td><td>A person subject to this rule shall reduce nitrogen oxide emissions (NO_X) from any glass melting furnace until emissions do not exceed the following limits:</td></tr>
<tr><td colspan="3">Container Glass:</td></tr>
<tr><td>NO_X</td><td>1.5 lb/ton[B]</td><td>5.5 lb/ton, averaged over any consecutive 3-hour period</td></tr>
<tr><td>PM_{10}</td><td>0.50 lb/ton[A]</td><td>No Limit Specified</td></tr>
</table>

	Fiberglass:		
	NO_X	1.3 lb/ton[A, C]	5.5 lb/ton, averaged over any consecutive 3-hour period
		3.0 lb/ton[A, D]	
	PM_{10}	0.50 lb/ton[A]	No Limit Specified
	Flat Glass:		
	NO_X Standard Option	3.7 lb/ton[A]	5.5 lb/ton, averaged over any consecutive 3-hour period
		3.2 lb/ton[B]	
	NO_X Enhanced Option	3.4 lb/ton[A]	
		2.9 lb/ton[B]	
	PM_{10}	0.70 lb/ton[A]	No Limit Specified

[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

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

Owens-Brockway Facility Location in Vernon, CA (SCAQMD)

Owens-Brockway operates a glass container manufacturing facility located in Vernon, CA. Prior to 2017, the facility consisted of two oxy-fuel fired glass melting furnaces. In the 4th quarter of 2017, this facility underwent construction and modification to install a Tri-Mer UltraCat ceramic catalytic filtration system (SCR system) on the exhaust of each of the oxy-fuel fired glass furnaces operated at this facility. This type of installation, pairing an oxy-fuel fired glass melting furnace with an SCR system, is the first of its kind anywhere in the world. Tri-Mer, the manufacturer and supplier of the SCR system installed at this facility, stated that with these two NO_X control systems in operation together, these glass furnaces could be able to achieve NO_X emission rates at a level as low as 0.20 pounds of NO_X per ton of glass produced.

The Owens-Brockway facility has been operating the oxy-fuel fired glass furnaces with the new SCR systems since the 1st quarter of 2018. Their preliminary source test data shows their furnace emissions levels are meeting 0.20 pounds of NO_X per ton of glass produced, on a 1-hour average basis. However, based on discussions the District has had with Owens-Brockway facility staff, they have experienced wide ranging spikes in their NO_X emissions from the glass furnaces while operating the new control systems and are still tuning the glass furnaces and control system operating parameters to optimize their NO_X emission control and still have the ability to produce a quality product. At this time, it is also not known how the new ceramic catalyst will perform over time and if the facility will be able to sustain emission rates as low as 0.20 pounds of NO_X per ton of glass produced.

In addition, despite continued efforts, the District has not been able to obtain the necessary information to reconcile Continuous Emission Monitoring System (CEMS) data with production data from the plant (glass pulled per hour, day, and month) to demonstrate continuous compliance with the 0.20 lb-NOx/tons of glass produced RECLAIM target. In conclusion, this technology is still under development, has not yet been achieved in practice, is not established as an enforceable permit limit or control measure, and cannot yet be considered a feasible technology at this time.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for glass melting furnaces. As demonstrated above, Rule 4354 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will pursue the following potential opportunities to reduce NOx emissions for container glass furnaces to the extent that additional NOx controls are technologically and economically feasible:

- Evaluate feasible ultra low-NOx control technologies (catalytic filtration, oxy-fuel combined with SCR, etc.)
- Lower NOx limit from 1.5 lb/ton to a level ranging from 1.0-1.2 lb-NOx/ton glass pulled or lower, based on a rolling 30-day average

The proposed commitments by the District and CARB will each achieve an aggregate emission reduction of direct PM2.5 and NOx. While the commitments include estimates of the emission reductions from each individual measure, final measures as proposed for adoption into the state implementation plan (SIP) may provide more or less emission reductions. The aggregate commitment will guarantee that the total emission reductions will be achieved to attain each NAAQS as expeditiously as practicable.

C.15 Rule 4550 (Conservation Management Practices)

Discussion

Rule 4550 is the District's Conservation Management Practices (CMP) rule. Rule 4550 was the first rule of its kind in the nation to reduce fugitive particulate emissions from agricultural operations through the required reduction in the number of passes through a field taken by agricultural equipment and through the implementation of other conservation practices. Rule 4550 established a then-unique menu approach of control techniques to accommodate the wide variability of agricultural industries found in the San Joaquin Valley, which approach has since been duplicated by other agencies. The selected CMPs are listed on application forms that are submitted to the District for approval as a CMP Plan. Approved CMP plans are enforced through onsite inspections and operators are required to submit applications to modify their plans when changing their conservation management practices. Agricultural operations are then required to maintain detailed records verifying use of the approved Conservation Management Practices. Through this rule, PM10 emissions have been reduced by 35.3 tons per day, which is approximately a 24% reduction for this source category.

The District worked extensively with stakeholders, growers, and the Agricultural Technical Committee for the San Joaquin Valley-wide Air Pollution Study Agency (AgTech) for two years prior to developing the original Conservation Management Practices (CMP) Rule, researching and gathering information on conservation management practices, their effectiveness in reducing PM10 emissions, and variations in effectiveness varied with various soil parameters, crop and animal types, and agronomic practices. Rule 4550 was adopted on August 19, 2004, as a PM10 control measure to help bring the Valley into attainment of federal PM10 standards. As noted above, Rule 4550 has since served as a model for other regions seeking to reduce fugitive PM10 emissions from agricultural sources.

Upon adoption of Rule 4550, the District embarked on an ambitious implementation strategy, working extensively with agricultural stakeholders to ensure that affected sources were assisted as much as possible in complying with the requirements, and consequently ensuring that the CMP Program was successful. To this end, the District created special CMP application forms, which were designed to allow growers to select approved practices from simplified checklists. A special web page was created that contains answers to frequently asked questions, application forms, and other forms of assistance for agricultural operations. The District hired additional staff, including additional Small Business Assistance (SBA) staff, and took part in over 40 workshops throughout the Valley to assist sources in completing and submitting the required CMP application forms. The workshops were coordinated with agricultural stakeholders, and tremendous outreach was performed to ensure that as many affected sources as possible would attend and receive assistance at the workshops.

As a result of these efforts, the District's CMP Program realized the following notable achievements:

- Approximately 4,000 participants attended workshops, with many of the participants submitting CMP Plan applications during the workshops.
- The District received and processed over 6,000 CMP Plan applications during 2005.
- The practices used by Valley agricultural sources encompass 3.2 million acres of farmland, and over 30,000 miles of unpaved roads.
- The PM10 reductions are quantifiable and enforceable through approved CMP plans and subsequent inspections.
- The collaborative effort that resulted in the CMP program received US EPA Region IX's "2005 Environmental Award for Outstanding Achievement."

The District also conducted an additional 60 workshops throughout the Valley since 2005 for the purpose of assisting sources to comply with the CMP rule and other ag-related issues and requirements.

EPA finalized approval of Rule 4550 on February 14, 2006 and determined that the rule met BACM requirements.[61] 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.[62,63]

Emissions Inventory

While Rule 4550 was designed to reduce PM10, and was very successful in doing so, it also generates reductions of PM2.5, as discussed in more detail later in this chapter. The emissions inventory for the category, as impacted by the current rule, is as follows:

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	18.78	18.54	18.30	18.22	18.14	18.06	17.98	17.90	17.82
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day								
PM2.5	15.05	14.82	14.59	14.51	14.43	14.35	14.28	14.20	14.12
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

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[61] 71 Federal Register 30, 7683-7688. (2006, February 14). *Revisions to the California State Implementation Plan; San Joaquin Valley Unified Air Pollution Control District*. Retrieved from http://www.gpo.gov/fdsys/pkg/FR-2006-02-14/pdf/06-1311.pdf

[62] 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

[63] SJVAPCD. *Court rules in favor of Air District ag rule. Second decision this week affirms PM progress.* Retrieved from https://www.valleyair.org/recent_news/Media_releases/2009/PR%20Court%20decision%20favors%20District%20ag%20rule.pdf

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.

<u>Fugitive PM2.5 Dust Emissions from Agricultural Operations</u>

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.[64] 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. [65]

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, Modesto, and Visalia found that the annual average geologic fraction during 2011-2013 was 12%, 5%, and 6%, respectively, and the speciation analysis of PM2.5 in Fresno during 2012-2014, found that the annual average geologic fraction was 7%.[66] 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.[67]

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%).[68] This ratio estimate is substantially

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

[65] 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. http://toxsci.oxfordjournals.org/content/82/1/88.full.pdf+html doi: 10.1093/toxsci/kfh24
Rogge, W. F., Hildemann, L. M., Mazurek, M. A., Cass, G. R. and Simoneit, B. R. T. *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. 1993.

[66] California Air Resources Board (2016) ARB Staff Report: ARB Review of San Joaquin Valley 2016 Moderate Area Plan for the 2012 PM2.5 Standard https://www.arb.ca.gov/planning/sip/sjvpm25/2016pm25/2016pm25staffreport.pdf

San Joaquin Valley Air Pollution Control District (SJVAPCD) 2016 Moderate Area Plan for the 2012 PM2.5 Standard, Chapter 2 Risk-Based Strategy. http://www.valleyair.org/Air_Quality_Plans/docs/PM25-2016/2016-Plan.pdf

California Air Resources Board (2015) Modeling Documentation for the 2015 PM2.5 Plan for the San Joaquin Valley, Methodology and Results - Attainment Demonstration for the San Joaquin Valley 2015 PM2.5 Plan for the Annual (15 µg/m3) and 24-Hour (65 µg/m3) Standards.
https://www.arb.ca.gov/planning/sip/planarea/Attainment_Demo_Methodology_and_Results.pdf

[67] 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. https://www3.epa.gov/ttnchie1/conference/ei10/fugdust/countess.pdf

[68] 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.

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's1996 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 US EPA at the 2005 US EPA Emissions Inventory Conference, MRI's1996 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, [69] 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).**Error! Bookmark not defined.**

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.[70] This is due to the low release height and turbulence which keeps particles temporarily close to the surface 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

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https://www.epa.gov/ttn/chief/conference/ei12/fugdust/countess.pdf
https://www.epa.gov/ttn/chief/conference/ei12/fugdust/present/countess.pdf

[69] 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.
https://www3.epa.gov/ttnchie1/conference/ei14/session5/pace.pdf
https://www3.epa.gov/ttnchie1/conference/ei14/session5/pace_pres.pdf

[70] 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. https://www3.epa.gov/ttnchie1/conference/ei10/fugdust/countess.pdf
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.
https://www3.epa.gov/ttnchie1/conference/ei12/fugdust/fitz.pdf
https://www.epa.gov/ttn/chief/conference/ei12/fugdust/present/fitz.pdf

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. [71] 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%).[72]

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. While placing further controls on this source will not make a substantial difference in the District's PM2.5 design values, the District will be analyzing additional CMP options for fallow lands and tillage operations, as discussed in section C.1.5 below.

HOW DOES DISTRICT RULE 4550 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There are no air quality requirements such as federal NSPS, NESHAP, MACT, CTGs, and ACTs for this source category.

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. EPA finalized approval of Rule 4550 on February 14, 2006, and determined that the rule met Best Available Control Measure (BACM)

[71] Retrieved from https://weatherspark.com
[72] California Air Resources Board (2012) ARB Staff Report: Proposed Revision to the PM2.5 State Implementation Plan (SIP) for the San Joaquin Valley, Appendix B: Weight of Evidence Analysis. https://www.arb.ca.gov/planning/sip/sjvpm25/2012plan_appendix_b.pdf

requirements of the Clean Air Act (CAA) 189(b).

For this Plan, 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 three analogous rules, in Arizona, South Coast AQMD, and Imperial County APCD.

However, it should be noted that our examination found that each of the rules discussed below were developed to reduce PM10 emissions from agricultural operations in PM10 non-attainment areas. This was the situation for the SJVAPCD CMP rule, as well – in fact, we believe that the District's ground-breaking CMP program was a significant contributor to the District's subsequent attainment of the PM10 standard.

None of these rules was 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 to establish BACM or MSM for PM2.5.

Nonetheless, the District examined the following rules and found that District Rule 4550 was, overall, as stringent or more stringent than each of them:

> ***Arizona Department of Environmental Quality-Agricultural Best Management Practices (BMPs)*** *(Amended June 30, 2010)*
>
> ***SCAQMD Rule 403 (Fugitive Dust)*** *(Amended June 3, 2005)*
>
> ***Imperial County APCD Rule 806 (Conservation Management Practices)*** *(Amended October 16, 2012)*

In January of 2016, the federal EPA agreed with this position, as published in their evaluation of the District's CMP rule as a part of a Technical Support Document (TSD) related to their proposed approval of the District's 2015 PM2.5 Plan. In that TSD, EPA found that District Rule 4550 meets BACM and MSM requirements and "is at least as stringent as the analogous rules implemented elsewhere." In their approval, EPA specifically cited the significantly superior enforcement mechanisms in the District regulation, 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,
- It is the only rule to require owner/operators to maintain records for five years,

- It is the only rule to require confirmation of CMP implementation and demonstrations for claimed exemptions.

Evaluation Findings

As noted above, the existing District Rule 4550 has been found by the District and the federal EPA to establish RACM, BACM, and MSM level PM2.5 requirements for this source category.

While the attainment modeling process has demonstrated that additional CMPs will not significantly contribute to our attainment efforts, to further develop the District's understanding of the effectiveness of CMP measures on controlling PM2.5 emissions in the Valley, the District is committing to undertaking 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.

Although Rule 4550 already meets BACM and MSM requirements for PM2.5, the District is also committing to further evaluate ways to promote conservation tillage practices and to reduce dust from agricultural operations to the extent that they are found to practicably reduce PM2.5, using the following process. The District will work with the Agricultural Technical Committee to evaluate the feasibility and effectiveness of requiring the selection of additional control measures to achieve additional PM2.5 emissions reductions from tilling and other land preparation activities based on the research discussed above. More widespread implementation of conservation tillage practices such as cover cropping, no till, low till, strip till, and precision agriculture, through additional incentives under Rule 4550, may help to further limit PM2.5 in the Valley. To this end, the District will evaluate measures to promote the selection of conservation tillage as a CMP for croplands.

The District will 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 will rely on additional research, in coordination with USDA-NRCS, agricultural sources, and researchers, that recognizes the Valley's unique soil characteristics and agricultural practices to ensure that Valley-specific solutions are considered in this process.

C.16 Rule 4692 (Commercial Charbroiling)

Discussion

The charbroiling source category consists of two types of commercial charbroilers: chain-driven and under-fired. A chain-driven charbroiler is a semi-enclosed broiler that moves food mechanically through the device on a grated grill to cook the food for a specific amount of time. An under-fired charbroiler has a metal "grid," a heavy-duty grill similar to that of a home barbecue, with gas burners, electric heating elements, or solid fuel (wood or charcoal) located under the grill to provide heat to cook the food. The smoke and vapors generated by cooking on either type of charbroiler contain water, VOCs, and PM. Larger particles and grease are typically captured by the grease filter of the ventilation hood over the charbroiler. The remaining VOCs and particulate pollution are exhausted outside the restaurant, unless a secondary control is installed.

The emission inventory for the source category of commercial charbroiling is comprised of both chain-driven and underfired charbroilers (see table below). Underfired charbroiling is responsible for approximately 89% of the PM 2.5 emissions for this source category, or 2.57 tons per day (tpd) of the 2.89 tpd emitted from commercial charbroiling in the Valley in 2013. Commercial charbroiling emissions contribute a significant fraction of the PM2.5 found in urban areas. A California Regional Particulate Air Quality Study (CRPAQS) study conducted in Fresno estimated that meat cooking contributed 6 to 14% of organic carbon aerosol found in the city. The same study found that charbroiled hamburger emits up to 40 grams of fine aerosol per kilogram of meat cooked, versus 7 grams per kilogram for extra lean meat. As under-fired charbroilers are the majority of the remaining total commercial charbroiling inventory, and because these units are currently unregulated in the Valley, there is a large potential to achieve emissions reductions from the regulation of under-fired charbroiling emissions.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	2.89	3.02	3.16	3.21	3.25	3.30	3.36	3.41	3.46
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	Winter Average - Tons per day								
PM2.5	2.89	3.02	3.16	3.20	3.25	3.30	3.35	3.41	3.46
NOx	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Source Category

Currently, District Rule 4692 reduces emissions by requiring catalytic oxidizers for chain-driven charbroilers that meet rule applicability thresholds. Charbroiler exhaust is directed 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 is transferred to a heat recovery system, so no additional fuel is needed for the unit. Rule 4692 requires emission controls for chain-driven charbroilers that cook

400 pounds of meat or more per week. Rule 4692 does not currently require emissions controls for under-fired charbroilers.

Catalytic oxidizers are not effective for reducing emissions from under-fired charbroilers because the exhaust from these devices loses heat as it is directed to the control device, and the reactions at the catalyst cannot take place under these lower temperatures. In a chain-driven charbroiler, charbroiling exhaust is directed 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 is transferred to a heat recovery system, so no additional fuel is needed for the unit. Controlling emissions from under-fired charbroilers has proven to be far more challenging. To date, no cost effective technologies have been demonstrated as achieved in practice. As such, the rule currently does not have requirements specific to underfired charbroilers.

The original rule, adopted in March 2002, reduced PM2.5 emissions from chain-driven charbroilers by 84%. The September 2009 rule amendment expanded rule applicability to more chain-driven charbroilers, reducing 25% of the remaining PM2.5 chain-driven charbroiler emissions. EPA finalized approval for Rule 4692 on November 3, 2011[73]. The District evaluated Rule 4692 in its RACT State Implementation Plan (SIP) demonstration; however, EPA noted in its Technical Support Document (TSD) for the approval of Rule 4692 that the rule is not subject to RACT because it is not subject to Control Techniques Guidelines (CTG) requirements and it does not regulate major sources.

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

Federal Regulations
There are no EPA CTG, ACT, NSPS, NESHAP, or MACT requirements for this source category.

State Regulations
There are no state regulations applicable to air quality from commercial charbroiling activities.

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

There are no analogous rules for this source category in SMAQMD.

BAAQMD

- BAAQMD Regulation 6 Rule 2 (Commercial Cooking Equipment) *(Last amended December, 5, 2007)*

BAAQMD Regulation 6 Rule 2 regulates both chain-driven and under-fired units, and was adopted on December 5, 2007. Operations that become subject to the rule

[73] EPA Federal Register, Volume 76 No. 213. (November 3, 2011). Codified at: 40 C.F.R. pt. 52

requirements with chain-driven charbroilers are required to install a certified control device to limit PM10 emissions to not more than 1.3 pounds PM10 per 1,000 lbs of beef cooked. Newly installed under-fired units with more than 10 square feet of cooking area are required to limit emissions to 1 lb of PM10 per 1,000 lbs of cooked beef. Effective January 2013, the same emissions requirements also apply to pre-existing units. This rule exempts low-use chain-driven charbroilers that grill less than 400 lbs of beef per week, and exempts underfired charbroilers that grill less than 800 lbs of beef per week. Although this rule was adopted in 2007 and has had requirements in effect since 2010, the majority of under-fired charbroilers in the Bay Area are able to avoid the control requirements based on the established grill size and throughput exemptions. Additionally, since adoption of the rule, the BAAQMD has not certified any compliant control devices. BAAQMD has not been enforcing this rule or doing inspections on restaurants until they create a list of certified, approved technology, and as a result, no installations of controls has occurred under this rule.

The District evaluated the requirements contained within BAAQMD's Regulation 6, Rule 2 and found no requirements that were more stringent than those already in Rule 4692 for chain-driven charbroilers.

	SJVAPCD	BAAQMD
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 less than 400 lbs of meat per week, or less than 10,800 lbs of meat per week and the total amount of meat cooked per week does not exceed 875 lbs.	Chain-driven charbroilers that cook less than 400 lbs of beef per week; underfired charbroilers which cook less than 800 lbs of beef 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 the installation of a certified catalytic oxidizer (controlled to 1.3 lbs of PM10 and 0.32 lbs VOCs per 1,000 lbs of beef cooked) Underfired Charbroiler requirements specify that emissions be limited to no more that 1lb PM10 per 1000 lbs of beef cooked for new and existing units.

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) *(Amended May, 2016)*

Passed in May, 2016, this rule essentially requires the installation of a control device which is certified to provide at least 75% emissions reductions for new underfired charbroilers and for any new or existing chain-driven charbroiler used to cook 875 lbs or more of meat per week. Registration and the payment of a $100 administration fee are required for existing charbroiler units. Consideration of control requirements for existing units has been pushed back until at least 2019 due to the feasibility questions and higher cost of retrofitting existing operations. New York staff are in the introductory stages of establishing an inventory and planning for inspections and enforcement, with no control installations yet required under the rule.

The requirements of District Rule 4692 are more stringent that those found in NYC's Section 24-149.4 for chain-driven charbroilers. The District has recently amended Rule 4692 to require the registration of underfired charbroiler units, and is evaluating the feasibility of controls for new and existing underfired units.

	SJVAPCD	NYDEP
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 less than 400 lbs of meat per week, or less than 10,800 lbs of meat per week and the total amount of meat cooked per week does not exceed 875 lbs.	Charbroilers that cook less than 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.	**Chain-driven**: requires catalytic oxidizer or control of PM10 by 75%. **Under-fired:** Registration requirement for existing units. New units required to install control devices to limit PM emissions by 75% (currently unenforced)

SCAQMD

- SCAQMD Rule 1138 (Control of Emissions from Restaurant Operations) *(Amended November 14, 1997)*

In November 1997 South Coast Air Quality Management District (SCAQMD) adopted Rule 1138, which achieved 0.5 tons per day of PM10 emissions from chain-driven charbroilers. In 1999 they amended their attainment plan to include a commitment to further reduce 0.9 tons per day of VOC and 7.0 tons per day of PM10 emissions. However, in August 2000, SCAQMD staff reported that cost-effective controls for underfired charbroilers were limited and recommended substituting the remaining 0.9 tons per day of VOC emissions reductions assigned to this category with reductions from another control measure. Their 2003 air quality management plan (AQMP) included reducing PM10 from under-fired charbroilers by 1 ton per day by 2010. A report to the SCAQMD Board in 2004 demonstrated that controls from under-fired charbroilers were infeasible and again substituted emissions reductions from other adopted rules. To help advance the demonstration of these technologies, South Coast recommended funding for demonstration projects and their Board approved $200,000 to fund six to eight new or retrofit demonstration sites on large restaurants. However, no applications were received for that program. In 2008-2009, AQMD staff reinitiated rule development for restaurants with under-fired charbroilers and held a series of working group meetings and a public workshop. Due to lack of demonstrable cost-effective and affordable control technologies SCAQMD staff determined rule adoption at that time was not feasible.

The recent amendment of the SCAQMD air quality management plan included the future adoption of a rule for underfired charbroilers as a contingency measure.
The District evaluated the requirements contained within SCAQMD's Rule 1138 and found no requirements that were more stringent than those already in Rule 4692.

	SJVAPCD	SCAQMD
Applicability	Chain-driven charbroilers and underfired charbroilers at commercial cooking operations	Chain-driven charbroilers
Exemption	Charbroilers that cook less than 400 lbs of meat per week, or less than 10,800 lbs of meat per week and the total amount of meat cooked per week does not exceed 875 lbs	Exempt if (1) accept a permitting condition limiting the amount of meat cooked to less than 875 lbs per week; or (2) submit testing showing that emissions are less that 1lb per day
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.	Only operate a chain-driven charbroiler with an approved catalyst, plus maintenance requirements and recordkeeping.

VCAPCD

- VCAPCD Rule 74.25 (Restaurant Cooking Operations) *(Amended October 12, 2004)*

VCAPCD Rule 74.25 applies to all conveyorized charbroilers, and requires that the owner of a conveyorized charbroiler reduce ROG and PM emissions by 83% through the installation of a certified control device. The rule exempts charbroilers placed into service before October 12, 2005 that cook less than 875 pounds per week. The District evaluated the requirements contained within VCAPCD's Rule 74.25 and found no requirements that were more stringent than those already in Rule 4692.

	SJVAPCD	VCAQMD
Applicability	Chain-driven charbroilers and underfired charbroilers at commercial cooking operations	Conveyorized (chain-driven) charbroilers)
Exemption	Charbroilers that cook less than 400 lbs of meat per week, or less than 10,800 lbs of meat per week and the total amount of meat cooked per week does not exceed 875 lbs.	Charbroilers placed into service prior to Oct. 2005 that cook less than 875 lbs per week (no exemption for throughputs for units installed after Oct. 2005)
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 the installation of an approved control device to reduce PM emissions by 83%.

Additional Emission Reduction Opportunities

EPA interprets MSM to assure additional controls that can be feasibly implemented beyond the set of measures adopted as BACM are implemented. This is done through evaluation of expanding rule applicability, or re-analyzing measures that were rejected during the BACM analysis to see if they are now feasible. Beyond the review of current regulation and rule requirements, the District performed an extensive review of the feasibility of expanding applicability or removal of exemptions for this source category, technologies and measures that have been implemented in practice in other regions, and potential new technologies and measures that may be feasible for implementation in the near future.

Pursuant to District Rule 4692 and District Rule 2010 (Permits Required), all chain-driven charbroilers are required to have a Permit to Operate. A 2018 review of District permits showed that all commercial cooking operations with a permit for chain-driven charbroilers had applied for a permit level which exceeds the 400 lbs. per week limit, even if their actual throughput was below this amount. These operations installed and maintain an approved catalytic oxidizer for compliance with their permit requirements. Due to the requirement for all operations with a chain-driven charbroiler to obtain a Permit to Operate, and because all permits are currently for an amount above the exemption limit, all permitted charbroilers in the Valley have installed a catalytic oxidizer. No emission reductions would occur from lowering the exemption level for chain-driven charbroilers.

For this attainment plan, the District evaluated the feasibility of requiring pollution controls for commercial cooking operations with underfired charbroilers. District staff have made the following findings with respect to the current state of underfired charbroiling control technologies:

- *There has been an increasing number of particulate control technology installations primarily at new or newer restaurants in response to local ordinances and nuisance concerns*: Based on discussions with control technology manufacturers and vendors, an increasing number of particulate control technologies have been installed at restaurants in dense urban areas to address nuisance requirements and concerns. The majority of these installations have been at new or newer restaurants. It is unclear how many of these installations have been at restaurants with underfired charbroilers as it has been difficult to obtain this information from technology vendors and restaurants directly. Restaurants that the District has been able to identify as having installed underfired charbroiling control technologies include Chipotle (multiple installations outside of Valley), Yard House (multiple installations outside of Valley), Bourbon’s Steak & Pub at Levi’s Stadium (San Francisco, CA), Deli Delicious (Visalia, CA), Season’s 52 (multiple installations outside of Valley), Capital Grill (multiple installations outside of Valley), and the Habit Burger Grill (multiple installations inside and outside of Valley).

- *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 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. Installing the control equipment may require the restaurant to temporarily shut down, resulting in loss of revenue. 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.

- *Installation cost of controls can be prohibitively expensive*: The cost of control units themselves are expensive, ranging from $30,000 up to $80,000 for the most complicated unit configurations. In addition, installation costs range from $10,000 to $20,000 for new construction and $20,000 to $60,000 or higher, depending on the structural and electrical modifications required, for retrofits. It is possible that some high-volume restaurants may be able to support this cost, but restaurants with less income would be financially unable to install these units without incentive support.

- *Maintenance of controls can be prohibitively expensive*: Regular maintenance of control devices is critical to ensure control effectiveness. Depending on the control technology and the type and volume of food cooked, filter change-out is required on a monthly or quarterly basis, with more in-depth filter replacement or unit cleaning required annually. Annual maintenance costs including both labor and materials starts around $6,000 and can exceed $100,000 for the highest volume restaurants with solid-fuel fired underfired charbroilers.

- *Maintenance requires specially trained staff that may not be accessible to all restaurants*: Control device cleaning is a complex process, requiring specially trained staff. Training restaurant staff to perform this task may not be feasible, and service companies capable of performing the maintenance may not be readily available nearby. Any delays in required maintenance could cause significant economic impacts to restaurants.

Due to the potential lack of economic and technological feasibility of requiring these controls, the District is first seeking to require registration of underfired charbroilers pursuant to Rule 2250 (Permit-Exempt Equipment Registration) and recently amended Rule 4692 to require the submittal of a one-time report from all Valley commercial cooking operations with an underfired charbroiler. This report will detail meat throughputs, hours of operation, and any installed control technology. Information obtained through the registration and reporting process will be used to further evaluate the feasibility of requiring controls for this source category.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this source category. As demonstrated above, Rule 4692 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

After thorough review of potential opportunities to reduce emissions from this source category, the District amended Rule 4692 to implement a registration and reporting requirement for underfired charbroiler operations in order to gather better inventory and emissions information for this source category. Using new survey and registration information, the District will pursue reductions in commercial underfired charbroiler emissions through an incentive-based approach to fund the installation of controls for commercial underfired charbroilers within urban boundaries in hot-spot areas, with a future year regulatory requirement to encourage participation by Valley businesses.

1. To ensure early and robust use of incentives for installation of controls and related modifications for existing underfired charbroilers within urban boundaries of hot-spots areas supplemented with regulatory backstop to encourage participation.

2. Require installation of control technologies at new larger restaurants within urban boundaries of hot-spot areas supplemented by incentives as feasible.

C.17 Rule 4702 (Emissions from Internal Combustion Engines)

Discussion

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, carbon monoxide (CO), VOC, and SOx emissions from units subject to this rule.

The District's original IC engine rule, Rule 4701 (Internal Combustion Engines – Phase 1), was adopted on May 21, 1992, superseded by Rule 4702, adopted on August 21, 2003, and subsequently amended five times. The rule established NOx limits between 25-50 ppmv achieving 90-96% control for non-agricultural operation rich-burn engines, and 65-75 ppmv achieving 85-90% control for non-agricultural operation lean-burn engines.

Substantial emission reductions from agricultural IC engines have also been achieved through a combination of regulatory efforts and incentive actions. Rule 4702 has reduced emissions from agricultural engines by 84% since the 2005 amendments to the rule, with substantial investments being made by the affected sources to comply with the rule. This effort included working closely with agricultural sources, publicly owned utilities, and the U.S. Department of Agriculture-Natural Resources Conservation Service to develop a collaborative model of extensive outreach, strong incentives to assist in defraying high costs, and significant investments from agricultural sources to replace thousands of agricultural engines to comply with Rule 4702. The rule was further strengthened in August 2011 when rule amendments implemented more stringent NOx limits as low as 11 ppmv for spark-ignited engines used in non-agricultural operations.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.36	0.25	0.23	0.22	0.22	0.20	0.20	0.19	0.19
NOx	9.37	5.56	5.01	4.79	4.67	4.33	4.20	4.08	3.97
	Winter Average - Tons per day								
PM2.5	0.49	0.32	0.29	0.28	0.27	0.25	0.24	0.23	0.22
NOx	12.94	7.29	6.46	6.18	5.99	5.52	5.34	5.16	5.00

Source Category

An internal combustion engine is an engine that operates by burning its fuel inside the engine. Engines generate power by the combustion of an air/fuel mixture. The main types of engines are spark-ignited engines and compression-ignited (or diesel) engines. In the case of spark-ignited engines, a spark plug ignites the air/fuel mixture. Spark-ignited engines come in several designs, including rich-burn and lean-burn. Spark-ignited engines may use one or more fuels, such as natural gas, propane, butane, liquefied petroleum gas, oil field gas, digester gas, landfill gas, methanol, ethanol, and gasoline. Compression-ignited engines rely on heating of the inducted air during the compression stroke to ignite the injected diesel fuel. In addition to being classified into compression-ignited and spark-ignited, IC engines can be further divided into two-stroke and four-stroke engines. While larger diesel engines may be two-stroke, most diesel engines are four-stroke. Natural gas fired spark-ignited engines are usually four-stroke, two-stroke engines may be more appropriate for certain applications.

Internal combustion engines are used by a variety of private businesses and public agencies throughout the Valley for a number of purposes. Primary uses of IC engines in the Valley include powering irrigation pumps, compressors, or electrical generators. Examples of businesses and industries that use IC engines include schools and universities, agriculture, oil and gas production and pipelines, petroleum refining, manufacturing facilities, food processing, electrical power generation, landfill and waste water treatment facilities, and water districts. Many IC engines in the Valley are limited or low use in nature, such as emergency standby engines that provide backup power when electric service is interrupted.

HOW DOES DISTRICT RULE 4702 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There are no EPA Control Technique Guidelines (CTG) requirements for this source category.

Alternative Control Technology (ACT)

- EPA – 453/R-93-032 (Alternative Control Techniques Document – NOx Emissions from Stationary Internal Combustion Engines)

The District evaluated the requirements contained within the EPA – 453/R-93-032 ACT document and found no requirements that were more stringent than those already in Rule 4702.

Standards of Performance for New Stationary Sources (NSPS)

- 40 CFR 60 Subpart IIII (Standards of Performance for Stationary Compression Ignition Internal Combustion Engines)

The District evaluated the requirements contained within 40 CFR 60 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)

The District evaluated the requirements contained within 40 CFR 60 Subpart JJJJ and found no requirements that were more stringent than those already in Rule 4702.

NESHAP/ MACT

- 40 CFR 63 Subpart ZZZZ (NESHAP for Stationary Reciprocating Internal Combustion Engines)

The District evaluated the requirements contained within 40 CFR 63 Subpart ZZZZ NESHAP and found no requirements that were more stringent than those already in Rule 4702.

State Regulations

The following state regulations apply to sources covered under Rule 4702:

- 17 CCR 93114 (ATCM to Reduce Particulate Emissions from Diesel-Fueled Engines—Standards for Nonvehicular Diesel Fuel)
- 17 CCR 93115 (ATCM for Stationary Compression Ignition Engines)

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

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

The requirements and applicability of Rule 4702 were compared to analogous rules in other air districts and states to determine the stringency of Rule 4702 compared to those other rules.

BAAQMD

- BAAQMD Regulation 9 Rule 8 (Nitrogen Oxides and Carbon Monoxide from Stationary Internal Combustion Engines) *(Amended July 25, 2007)*

Although for one minor limited use category the BAAQMD rule may apply a more stringent limit, SJVAPCD's Rule 4702 has significantly more stringent limits all other categories of engines. In addition, ag engines are exempt from the BAAQMD rule, while SJVAPCD's Rule 4702 has established NOx and PM limits for ag engines for many years. Therefore, the District found the requirements contained within BAAQMD Regulation 9 Rule 8 are not more stringent than those already in District Rule 4702.

	SJVAPCD	BAAQMD
Applicability	Internal combustion engine rated at ≥ 25 bhp	Internal combustion engine rated at ≥ 50 bhp
Exemption	Limited to operate less than 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 6/1/04) De-rated engine that has been physically limited and restricted by permit to an	Engines rated by < 50 bhp Low Use Engines (varying from 100 hrs to 200 hrs) Engines used directly and exclusively for the growing of crops or the raising of animals

	operational level of < 50 bhp used in agricultural operation (prior to 6/1/05)		
	NOx Emission Limits **Non-Agricultural Operations (Non-AO) Engines Rated >50 bhp** *(corrected to 15% oxygen on a dry basis)*		
	Rich Burn-Waste Gas Fueled	50 ppmv or 90% reduction	70 ppmv
	Rich-Burn Cyclic Loaded, Field Gas Fueled	50 ppmv	No such category
	Rich-Burn Limited Use	25 ppmv	No such category
	Rich-Burn Engine, “not listed above"	11 ppmv	25 ppmv
	Lean-Burn Two-Stroke, Gaseous Fueled, >50 bhp and < 100 bhp	65 ppmv	No such category
	Lean-Burn Limited Use	65 ppmv	No such category
	Lean-Burn Engine Used for Gas Compression	65 ppmv or 93% reduction	65 ppmv
	Lean-Burn Waste Gas Fueled	65 ppmv or 90% reduction	70 ppmv
	Lean-Burn Engine, "not listed above"	11 ppmv	65 ppmv
	NOx Emission Limits for Agricultural Operations (AO) **Spark-Ignited Engines Rated >50 bhp** *(corrected to 15% oxygen on a dry basis)*		
	Rich-Burn Spark	90 ppmv or 80% reduction	Exempt
	Lean-Burn Spark	150 ppmv or 70% reduction	Exempt
	NOx Emission Limits for Agricultural Operations (AO) **Certified Compression-Ignited Engine** *(corrected to 15% oxygen on a dry basis)*		

	Tier 1 or Tier 2	Meet EPA Tier 4 by12 years after installation date, but not later than 6/1/2018	Exempt
	Tier 3 or Tier 4	Meet certified compression-ignited engine standard in effect at time of installation	Exempt

SMAQMD

- SMAQMD Rule 412 (Stationary Internal Combustion Engines at Major Stationary Sources of NOx) *(Adopted June 1, 1995)*

Although in theory the SMAQMD's general limits for rich burn engines may be more stringent than some specialized categories found in the SJVAPCD rule, it is unlikely that engines exist in many of those categories in the SMAQMD. SJVAPCD's Rule 4702 has significantly more stringent limits for all identified engine categories, including the largest non-specialized use categories. In addition, ag engines are exempt from the SMAQMD rule, while SJVAPCD's Rule 4702 has established NOx limits for ag engines for many years. Therefore, the District found the requirements contained within SMAQMD Rule 412 are not more stringent than those already in District Rule 4702.

	SJVAPCD		SMAQMD
Applicability	Internal combustion engine rated at ≥ 25 bhp		Emissions limits apply to Internal combustion engine rated at ≥ 50 bhp
Exemption	Limited to operate less than 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 6/1/04) De-rated engine that has been physically limited and restricted by permit to an operational level of < 50 used in agricultural operation (prior to 6/1/05)		Engines used directly and exclusively for agricultural operations
	NOx Emission Limits **Non-Agricultural Operations (Non-AO) Engines Rated >50 bhp** *(corrected to 15% oxygen on a dry basis)*		
	Rich Burn-Waste Gas Fueled	50 ppmv or 90% reduction	No such category
	Rich-Burn Cyclic Loaded, Field Gas Fueled	50 ppmv	No such category
	Rich-Burn Limited Use	25 ppmv	No such category
	Rich-Burn Engine, "not listed above"	11 ppmv	25 ppmv

	Lean-Burn Two-Stroke, Gaseous Fueled, >50 bhp and < 100 bhp	65 ppmv	No such category
	Lean-Burn Limited Use	65 ppmv	No such category
	Lean-Burn Engine Used for Gas Compression	65 ppmv or 93% reduction	No such category
	Lean-Burn Waste Gas Fueled	65 ppmv or 90% reduction	No such category
	Lean-Burn Engine, "not listed above"	11 ppmv	65 ppmv
	NOx Emission Limits for Agricultural Operations (AO) Spark-Ignited Engines Rated >50 bhp *(corrected to 15% oxygen on a dry basis)*		
	Rich-Burn Spark	90 ppmv or 80% reduction	Exempt
	Lean-Burn Spark	150 ppmv or 70% reduction	Exempt
	NOx Emission Limits for Agricultural Operations (AO) Certified Compression-Ignited Engine *(corrected to 15% oxygen on a dry basis)*		
	Tier 1 or Tier 2	EPA Tier 4 12 years after installation date, but not later than 6/1/2018	Exempt
	Tier 3 or Tier 4	Meet certified compression-ignited engine standard in effect at time of installation	Exempt

VCAPCD

- VCAPCD Rule 74.9 (Stationary Internal Combustion Engines) *(Amended November 8, 2005)*

Although in theory the VCAPCD's general limits for lean burn engines may be more stringent than some specialized categories found in the SJVAPCD rule, it is unlikely that engines exist in many of those categories in the VCAPCD. SJVAPCD's Rule 4702 has significantly more stringent limits for all identified engine categories, including the largest non-specialized use categories. In addition, ag engines are exempt from the

VCAPCD rule, while SJVAPCD's Rule 4702 has established NOx limits for ag engines for many years. Therefore, the District found the requirements contained within VCAPCD Rule 74.9 are not more stringent than those already in District Rule 4702.

<table>
<tr><th></th><th colspan="2">SJVAPCD</th><th>VCAPCD</th></tr>
<tr><td>Applicability</td><td colspan="2">Internal combustion engine rated at ≥ 25 bhp</td><td>Internal combustion engine rated at ≥ 50 bhp</td></tr>
<tr><td>Exemption</td><td colspan="2">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 6/1/04)
De-rated engine that has been physically limited and restricted by permit to an operational level of < 50 used in agricultural operation (prior to 6/1/05)</td><td>Engines rated < 50 hp
Engines operating < 200 hrs/yr
Engines rated < 100 hp, emitting no more than
The rule exempts engines used directly and exclusively for the growing of crops or the raising of animals</td></tr>
<tr><td rowspan="12"></td><td colspan="3">NOx Emission Limits
Non-Agricultural Operations (Non-AO) Engines Rated >50 bhp (corrected to 15% oxygen on a dry basis)</td></tr>
<tr><td>Rich Burn-Waste Gas Fueled</td><td>50 ppmv or 90% reduction</td><td>50 ppmv</td></tr>
<tr><td>Rich-Burn Cyclic Loaded, Field Gas Fueled</td><td>50 ppmv</td><td>No such category</td></tr>
<tr><td>Rich-Burn Limited Use</td><td>25 ppmv</td><td>No such category</td></tr>
<tr><td>Rich-Burn Engine, “not listed above"</td><td>11 ppmv</td><td>25 ppmv</td></tr>
<tr><td>Lean-Burn Two-Stroke, Gaseous Fueled, >50 bhp and < 100 bhp</td><td>65 ppmv</td><td>No such category</td></tr>
<tr><td>Lean-Burn Limited Use</td><td>65 ppmv</td><td>No such category</td></tr>
<tr><td>Lean-Burn Engine Used for Gas Compression</td><td>65 ppmv or 93% reduction</td><td>No such category</td></tr>
<tr><td>Lean-Burn Waste Gas Fueled</td><td>65 ppmv or 90% reduction</td><td>125 ppmv</td></tr>
<tr><td>Lean-Burn Engine, "not listed above"</td><td>11 ppmv</td><td>65 ppmv</td></tr>
<tr><td colspan="3">NOx Emission Limits for Agricultural Operations (AO)
Spark-Ignited Engines Rated >50 bhp
(corrected to 15% oxygen on a dry basis)</td></tr>
<tr><td>Rich-Burn Spark</td><td>90 ppmv or 80% reduction</td><td>Exempt</td></tr>
</table>

	Lean-Burn Spark	150 ppmv or 70% reduction	Exempt
	NOx Emission Limits for Agricultural Operations (AO) **Certified Compression-Ignited Engine** *(corrected to 15% oxygen on a dry basis)*		
	Tier 1 or Tier 2	Meet EPA Tier 4 by12 years after installation date, but not later than 6/1/2018	Exempt
	Tier 3 or Tier 4	Meet certified compression-ignited engine standard in effect at time of installation	Exempt

SCAQMD

- SCAQMD Rule 1110.2 (Emissions from Gaseous- and Liquid-Fueled Engines) (*Amended June 3, 2016*)

South Coast Air Quality Management District (SCAQMD) regulates the emissions from IC engines through a combination of control measures. SCAQMD 1110.2 is directly applicable to IC engines and includes emissions limitations for various applications. SCAQMD's RECLAIM program (Rules 2000 – 2020) allows operators to purchase credits in lieu of instituting engine emissions controls otherwise required under SCAQMD 1110.2. Therefore, their limits must not be compared to emissions limitations included in District rules that must be met and do not have RECLAIM exemptions. Given these overlapping sets of requirements, Rule 4702 must be compared in context of both regulations. Additionally, many of the engine applications found in the San Joaquin Valley vary substantially from engine applications in SCAQMD; for example, based on discussion with SCAQMD, there are only two rich-burn engines used in agricultural operations operating hours of 1,900 hrs/yr and 1,500 hrs/yr. No lean-burn ag engines are operating in SCAQMD.

	SJVAPCD	SCAQMD
Applicability	Internal combustion engine rated at ≥ 25 bhp	Emissions limits apply to Internal combustion engine rated at ≥ 50 bhp
Exemption	Limited to operate less than 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 6/1/04)	Engines operating < 500 hr/yr or < 1 billion Btu/hr Agricultural where electrical motor is not possible due to

	De-rated engine that has been physically limited and restricted by permit to an operational level of < 50 used in agricultural operation (prior to 6/1/05)		utility company rejecting service Does not qualify for funding under CHSC Section 44229 to replace, retrofit or repower the engine Engines installed prior to 2/1/08, engines installed by electric utility on Santa Catalina Island, engines installed at remote locations without access to natural gas and electrical power RECLAIM facilities (NOx emissions only)
	NOx Emission Limits **Non-Agricultural Operations (Non-AO) Engines Rated >50 bhp** *(corrected to 15% oxygen on a dry basis)*		
	Rich Burn-Waste Gas Fueled	50 ppmv or 90% reduction	No such category
	Rich-Burn Cyclic Loaded, Field Gas Fueled	50 ppmv	No such category
	Rich-Burn Limited Use	25 ppmv	No such category
	Rich-Burn Engine, “not listed above"	11 ppmv	11 ppmv*
	Lean-Burn Two-Stroke, Gaseous Fueled, >50 bhp and < 100 bhp	65 ppmv	No such category
	Lean-Burn Limited Use	65 ppmv	No such category
	Lean-Burn Engine Used for Gas Compression	65 ppmv or 93% reduction	No such category
	Lean-Burn Waste Gas Fueled	65 ppmv or 90% reduction	No such category
	Lean-Burn Engine, "not listed above"	11 ppmv	11 ppmv*
	NOx Emission Limits for Agricultural Operations (AO) **Spark-Ignited Engines Rated >50 bhp** *(corrected to 15% oxygen on a dry basis)*		

	Rich-Burn Spark[74]	90 ppmv or 80% reduction	11 ppmv*
	Lean-Burn Spark[75]	150 ppmv or 70% reduction	11 ppmv*
	NOx Emission Limits for Agricultural Operations (AO) Certified Compression-Ignited Engine *(corrected to 15% oxygen on a dry basis)*		
	Tier 1 or Tier 2	Meet EPA Tier 4 by January 1, 2015 or 12 years after installation date, but no later than June 1, 2018	Tier 1: 11 ppmv NOx or Tier 4 by July 1, 2008* Tier 2: 11 ppmv NOx or Tier 4 by January 1, 2010*
	Tier 3 or Tier 4	Meet certified compression-ignited engine standard in effect at time of installation	11 ppmv NOx or Tier 4 by January 1, 2010*

**Sources not required to meet these limits through RECLAIM*

Medium and large operators in the South Coast Air Basin are most likely part of the South Coast RECLAIM program and are subsequently not required to meet the engine emission limitations included in Rule 1110.2. All facilities that emit over a certain threshold are required to participate in the RECLAIM program. As part of the RECLAIM program, certain companies receive emission allocations every year, usable for 12 months. The portion of the allocation not needed to offset the operator's own emissions can be sold to other companies. If the operator does not receive an emission allocation, they must buy emission credits from operators with unused emission allocations. In this way, the RECLAIM program is similar to a cap-and-trade program. The District does not have a RECLAIM-type program for this source category; therefore, all operators are required to meet the stringent emission limitations included in Rule 4702.

Although the SCAQMD emission level of 11 ppm has not yet been proven as technologically feasible in the remote agricultural settings found in the San Joaquin Valley, and it is unclear what percentage of facilities are complying with the current SCAQMD NOx limits for non-ag categories, the District evaluated the cost-effectiveness and feasibility of implementing an 11 ppmv NOx emission limit for the following categories of IC engines:

- Non-Agricultural Operations (Non-AO) Waste Gas Engines
- Non-AO Spark-Ignited Engines
    - Cyclic Loaded, Field Gas Fueled

[74] There are only 2 rich-burn spark ignited engines operating in SCAQMD per discussions with their staff
[75] There are no lean-burn spark ignited ag engines operating in SCAQMD per discussions with their staff

    - Limited Use Engines
        - Lean-Burn Engines
        - Rich-Burn Engines
    - Two-Stroke, Gaseous Fueled Engines 50-100 bhp
    - Lean-Burn Engines Used for Gas Compression
- Agricultural Operations (AO) Spark-Ignited Engines

To determine potential emissions reductions, the District used the following equations:

NOx = (BHP x HR x EF x LF) / (CF)

Where:

NOx	=	Current annual NOx emissions or potential annual NOx emissions in ton/year
BHP	=	engine power
HR	=	annual hours of operation
EF	=	NOx emission factor
LF	=	engine load factor
CF	=	conversion factor from grams to pounds

The estimated annual NOx emissions reduction was calculated using the following equation:

Potential Emissions Reduction = current annual NOx emissions – potential annual NOx emissions

Additional Emission Reduction Opportunities

<u>NOx Emission Limitation for Non-Agricultural Operations (Non-AO) Waste Gas Engines</u>:

The District analyzed the technological feasibility of lowering the NOx emission limit for waste gas engines and determined that due to the variability of waste gas, additional levels of NOx control on existing waste gas engines can pose significant technical and feasibility challenges.

Waste gas includes landfill gas, which is generated at landfills, and digester gas, which is generated from anaerobic digestion. Both landfill and digester gas result from the decomposition of organic matter by microorganisms in the absence of oxygen. Unlike pipeline natural gas, the composition of waste gas is not consistent or guaranteed. The heating value and composition of the gas (e.g. methane and oxygen contents) will vary with the type of materials that enter the landfill or digester and can fluctuate seasonally or even daily. Both landfill and digester gases contain impurities, such as siloxanes, sulfur compounds, and halides. Landfill gas also contains entrained particulate matter, and emissions from both landfill and digester gas may contain particulates that result from combustion of the impurities in the gas. The contaminants in waste gas can coat and/or poison catalysts, rendering them ineffective. Because of its variable composition and contaminants, untreated waste gas is not interchangeable with pipeline-quality natural gas and extensive and costly cleanup would be necessary to allow the use of catalytic emission controls needed to achieve 11 ppmv. This is not a practical option for most existing waste gas-fired engines, which were not designed to include the required gas systems and catalytic controls.

In addition to the District's efforts to identify additional potential technology options for this category, SCAQMD has also been evaluating this issue. In February 2008, SCAQMD amended Rule 1110.2 to include an 11 ppmv limit for waste gas engines rated at >50 bhp. The original compliance date for this emissions limit was July 1, 2012, with the assumption that SCAQMD would complete a Technology Assessment to verify the feasibility of available control technologies for waste gas engines. However, SCAQMD had to amend Rule 1110.2 in September 2012 to extend the compliance deadline for waste gas engines from 2012 to 2016 in order to allow for more time to complete their Final Technology Assessment. Following further evaluation, SCAQMD amended the rule to extend the compliance date to January 1, 2017 for all biogas engines with the exception of demonstration projects prior to January 2015 would be required to comply with emissions limit of 11 ppmv by January 1, 2018 or defer compliance to January 1, 2019 through an alternative compliance option. Additionally, these sources may also have been in a position to avoid installing additional NOx control technologies through their participation in SCAQMD's RECLAIM program.

District Rule 4702 contains the most stringent limits feasible for existing waste gas-fueled engines based on the use of combustion processes that minimize emissions without the use of post-combustion catalytic controls. Therefore, Rule 4702 meets or exceeds BACM and MSM for non-AO waste gas fueled spark-ignited engines. Additionally, the District continues to investigate potential NOx and SOx control technologies for waste gas engines through its Technology Advancement Program, with projects currently approved for funding that will continue to demonstrate new technologies in this sector.

NOx Emission Limitation for Non-AO Spark-Ignited Engines:

Cyclic Loaded, Field Gas Fueled

Cyclic-loaded, field gas fueled engines can achieve some level of control, but not the stringent level of control that can be imposed on engines that operate in a narrow and more stable range of loads. The exhaust gas temperature of cyclic loaded engines varies as a function of the engine load; however, catalyst chemistry is dependent on a minimum temperature to be effective in reducing emissions. When the cyclic load engine is operating in a particular engine load range, the exhaust gas temperature can reach the catalyst's effective range and allow for emissions to be well-controlled; however, as the engine cycles out of this load range, the exhaust gas temperature becomes too low for effective emissions control. Since the exhaust temperature fluctuates frequently for this category of units, it is technologically infeasible to require a lower NOx limit for cyclic loaded field-gas fueled engines. The current emission limit for this category of engines meets or exceeds BACM and MSM for these sources.

Limited Use Engines

During the 2011 amendments to Rule 4702, the District created this category of engines based on the high costs and cost effectiveness associated with the installation of additional controls for these engines (<4,000 hours of operation). The NOx emission reductions foregone from not lowering the existing NOx limits to 11 ppmv for limited use engines was insignificant (about 0.004 tons per day in 2011).[76]

The District re-evaluated the cost effectiveness of lowering the NOx emission limits to 11 ppmv for limited use non-AO rich-burn and lean-burn engines. The costs in the analyses below were gathered from information in the District's Permits database, IC engine manufacturers, emission control system manufacturers and suppliers, and operators.

Limited Use Lean-Burn Engines

When evaluating the ability to lower NOx emissions to 11 ppmv, an operator can either retrofit the existing lean-burn IC engine with a selective catalytic reduction (SCR) system or install a new lean-burn engine with an SCR system. In many cases, retrofitting an existing IC engine is technologically infeasible or may require substantial additional unanticipated costs (such as the incompatibility of an older engine with less sophisticated operating controls with additional control technology, additional labor/maintenance costs, etc.). However, for the purpose of evaluating all potential controls, the District has included both options in the below analysis.

Table C-9 Annual Costs for Retrofitting an Existing Limited Use Lean-Burn Engine and Installing a New Limited Use Lean-Burn Engine with SCR

Item	Assumptions/Methodology	Cost
Average Engine Power Rating	1,100 brake horsepower (bhp)	n/a
Annual Operation	2,500 hours (hr)	n/a
Capital Costs		
New Engine Cost (without SCR)	Includes: engine, freight, installation, start-up, additional equipment (belt guards, fuel connection, etc.), and tax	$300,000
Annualized Engine Capital Costs (10 years, 10%)	0.163 x New Engine Cost	**$48,900**
SCR Equipment & Installation Costs		

[76] SJVAPCD. (2011, August 18). *Adopt Revised Proposed Amendments to Rule 4702 (Internal Combustion Engines).* Retrieved from http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2011/August/Agenda_Item_10_Aug_18_2011.pdf

Item	Assumptions/Methodology	Cost
Total Equipment & Installation Costs	\$143,000 per engine Includes catalyst element, urea injection system, and related installation equipment and costs	\$143,000
Annualized SCR Capital Costs (10 years, 10%)	0.163 x Total SCR Capital Costs	**\$23,309**
Annual Operating and Maintenance Costs		
Annual Reagent (urea) Cost	\$2.5 per gallon; 1.2 gallon/hr Cost = \$2.5 x 1.2 x 2500 hr	\$7,500
Annual Increase in Fuel Cost (due to drop in fuel efficiency with SCR)	Fuel usage = 8,483.3 standard cubic feet per hour (scf/hr) (based on 33% HHV mechanical efficiency) Fuel cost (per 1,000 scf) = \$8.39 Fuel cost (per hour) = (8,483.3 x \$8.39) / 1,000) Fuel cost (per year) = hourly cost x 2,500 hr 2.5% drop in fuel efficiency Added Fuel Cost = Annual fuel cost x 2.5%	\$3,711
Annual Electricity Cost (for compressor)	3 hp compressor = 2.24 kW power rating Electricity rate for industrial operations = \$0.18462/kW-hr Hourly electricity cost = 2.24 kW x \$0.18462/kW-hr Daily meter charge = \$0 (no new electric meter installed) Annual electricity cost = hourly cost x 2,500 hr Total utility cost = Annual electricity cost + Annual meter charge	\$1,034
Annual Catalyst Cost	Life of catalyst = 5 years Cost per catalyst = \$20,000 Catalyst costs for 10 years = \$20,000 x 2 Annualized cost = \$40,000 x 0.163	\$6,520
Annual Maintenance Cost	Maintenance = \$0.015 per bhp per hour of operation Annual cost = \$0.015 x 1,100 bhp x 2,500 hr	\$41,250
Annual Operating & Maintenance (O&M) Costs	Annual O&M = Annual Reagent Cost+ Annual Increase in Fuel Cost + Annual Electricity Cost + Annual Catalyst Cost + Annual Maintenance Cost	**\$60,015**
Annual Cost for Retrofit of LB Engine with SCR	Annual O&M = Annual Reagent Cost+ Annual Increase in Fuel Cost + Annual Electricity Cost + Annual Catalyst Cost + Annual Maintenance Cost	**\$83,324**
Annual Cost for New LB Engine with SCR	Annualized Engine Capital Cost + Annualized SCR Capital Cost + Annual O&M Cost	**\$132,224**

The emissions reductions are calculated below:

BHP = 1,100 bhp
HR = 2,500 hours/year (hr/yr)
EF1 = 0.838 g-NOx/bhp-hr (equivalent to 65 ppmvd NOx at 15% O2; assuming 33% mechanical efficiency)
EF2 = 0.142 g-NOx/bhp-hr (equivalent to 11 ppmvd NOx at 15% O2; assuming 33% mechanical efficiency)
Load factor (LF) = 0.8
CF = 453.59 grams/pound (g/lb)

Current NOx = (BHP x HR x EF1 x LF) / (CF)
= (1,100 bhp x 2,500 hr/yr x 0.838 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 4,064 lb-NOx/year

Potential NOx = (BHP x HR x EF2 x LF) / (CF)
= (1,100 bhp x 2,500 hr/yr x 0.142 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 689 lb-NOx/year

Potential Emissions Reduction = Current NOx – Potential NOx
Potential Emissions Reduction = (4,064-689 lb) x (1 ton / 2,000 lb)
Potential Emissions Reduction = 1.69 tons/year

Cost Effectiveness (Limited Use Lean-Burn Engines)
The cost effectiveness is the added cost, in dollars per year, of the control technology, divided by the emissions reductions achieved, in tons per year. Based on the calculations above, the cost effectiveness of retrofitting or replacing current limited use lean-burn spark-ignited engines is as follows:

- Retrofitted limited use lean-burn engine with SCR: $49,304/ton of NOx reduced
- New limited use lean-burn engine with SCR: $78,239/ton of NOx reduced

Limited Use Rich-Burn Engines
An existing rich-burn IC engine operating in this category must use advanced emission control technology such as a non-selective catalytic reduction (NSCR) system in order to operate at the already low NOx emissions level of 25 ppmv. When evaluating the ability to lower NOx emissions to 11 ppmv, an engine will already be equipped with the major components for the required NSCR system like three-way catalyst (three-way catalyst), air-to-fuel ratio controller, sensors, and ignition system. However, the existing three-way catalyst element will not likely be able to achieve further NOx reductions and will need to be replaced. It is likely that the other components like air-to-fuel ratio controller and sensors would also need to be replaced since the existing components may be worn or even outdated (e.g., an older, single-point air-to-fuel ratio controller may not be able to consistently maintain the much lower NOx limit as well as a more modern and advanced multi-point controller). Thus, the replacement of the entire NSCR system may be needed. For the purposes of evaluating both feasible scenarios, the following analysis includes retrofitting an existing engine with a replacement catalyst element and retrofitting an existing engine with an entirely new NSCR system.

Table C-10 Annual Costs for Retrofitting an Existing Limited Use Rich-Burn Engine

Item	Assumptions/Methodology	Cost
Average Engine Power Rating	1,400 bhp	n/a
Annual Operation	2,000 hours (hr)	n/a
New NSCR System Capital Costs		
New NSCR System	Includes: NSCR catalyst element, air-to-fuel ratio controller, sensors, ignition system, and installation equipment and costs	$21,000
Annualized Catalyst Capital Cost (10 years, 10%)	0.163 x New NSCR System	**$3,423**
New NSCR Catalyst Element Capital Costs		
New NSCR System	Includes: NSCR catalyst element and installation	$5,000
Annualized Catalyst Capital Cost (10 years, 10%)	0.163 x New NSCR Catalyst Element	**$815**
Annual Cost for Retrofit of RB Engine with New NSCR System	Annualized NSCR System Capital Cost	**$3,423**
Annual Cost for Retrofit of RB Engine with New NSCR Catalyst Element	Annualized NSCR Catalyst Element Capital Cost	**$815**

The emissions reductions are calculated below:

BHP = 1,400 bhp
HR = 2,000 hours/year (hr/yr)
EF1 = 0.322 g-NOx/bhp-hr (equivalent to 25 ppmvd NOx at 15% O2; assuming 33% mechanical efficiency)
EF2 = 0.142 g-NOx/bhp-hr (equivalent to 11 ppmvd NOx at 15% O2; assuming 33% mechanical efficiency)
Load Factor (LF) = 0.8
CF = 453.59 grams/pound (g/lb)

Current NOx = (BHP x HR x EF1 x LF) / (CF)
= (1,400 bhp x 2,000 hr/yr x 0.322 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 1,590 lb-NOx/year

Potential NOx = (BHP x HR x EF2 x LF) / (CF)
= (1,400 bhp x 2,000 hr/yr x 0.142 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 701 lb-NOx/year

Potential Emissions Reduction = Current NOx – Potential NOx

Potential Emissions Reduction = (1,590 - 701 lb) x (1 ton / 2,000 lb)
Potential Emissions Reduction = 0.44 tons/year

Cost Effectiveness (Limited Use Rich-Burn Engines)
The cost effectiveness is the added cost, in dollars per year, of the control technology, divided by the emissions reductions achieved, in tons per year. Based on the calculations above, the cost effectiveness of retrofitting or replacing current limited use rich-burn spark-ignited engines is as follows:

- Retrofitted limited use rich-burn engine with new NSCR system: $7,780/ton of NOx reduced
- Retrofitted limited use rich-burn engine with new NSCR catalyst element: $1,852/ton of NOx reduced

Two-Stroke, Gaseous Fueled Engines 50-100 bhp
There is no control technology compatible with two-stroke, gaseous fueled engines, including SCR, which will allow these units to achieve a NOx emission limit below 75 ppmv. An 11 ppmv NOx emission limit is not technologically feasible for these engines; the current limit implements BACM and MSM for two-stroke, gaseous fueled engines less than 100 bhp.

Lean-Burn Engines Used in Gas Compression:

During the rule amendment in 2011, the District created this category of engines based on the technological infeasibility to control these types of engines. Lean-burn engines used in gas compression in the Valley are used in natural gas distribution and storage service, and these engines frequently experience changing load conditions. As noted in EPA's Stationary IC Engine Technical Support Document[77], SCR use is problematic for these engines due to the fluctuations over a broad range of conditions. For this reason, EPA states that there is an insufficient basis to conclude that SCR is an appropriate technology for large lean-burn engines used for gas compression. The current emission limit is achievable through low-NOx combustion technology, which includes changes to the engine's timing, enhanced control of the air-fuel ratio, and other changes that lower NOx emissions. Due to the technological complexities associated with lean-burn engines used in gas compression, the current emissions limit implements MSM for these units.

Lean-Burn "Not Listed Above"

During the rule amendments in 2011, the District identified categories of non-ag spark-ignited engines and corresponding NOx emission limits that took into account the differences between engines used for different applications. The "not listed above" category accounts for all engines other than those that fit into a specific named category and provides a NOx emissions limit of 11 ppmv for lean-burn engines.

[77] EPA. (2003, October). *Stationary Reciprocating Internal Combustion Engines Technical Support Document for NOx SIP Call*.

Through complying with the current rule limit, engines in this category have already achieved significant NOx emissions reductions through use of advanced emissions controls like SCR systems. Since a lean-burn engine in this category will already be equipped with an SCR system, the engine will also already be equipped with the major components for the required SCR system like SCR catalyst element, air-to-fuel ratio controller, sensors, and urea injection system. However, the existing SCR catalyst element will not likely be able to achieve further NOx reductions and will need to be replaced. It is also likely that older engines in this category cannot reliably achieve the emissions reductions required to achieve a NOx emissions limit of 5 ppmv with just a replacement SCR catalyst element. In this case, an entirely new lean-burn engine with new SCR system will be required. For the purposes of evaluating both feasible scenarios, the following analysis includes retrofitting an existing engine with a replacement SCR catalyst element and installing an entirely new lean-burn engine with new SCR system.

Table C-11 Annual Costs for Replacing an Existing SCR Catalyst Element in a Lean-Burn Engine and Installing a New Lean-Burn Engine with SCR System

Item	Assumptions/Methodology	Cost
Average Engine Power Rating	4,157 brake horsepower (bhp)	n/a
Annual Operation	4,000 hours (hr)	n/a
New Engine Capital Costs		
New Engine Cost (without SCR)	Includes: engine, freight, installation, start-up, additional equipment (belt guards, fuel connection, etc.), and tax (SCR system is a separate cost)	$300,000
Annualized Engine Capital Costs (10 years, 10%)	0.163 x New Engine Capital Cost	**$48,900**
SCR System Capital Costs		
SCR System Cost	Includes catalyst element, urea injection system, catalyst housing, and related installation equipment and costs	$143,000
Annualized SCR System Capital Costs (10 years, 10%)	0.163 x SCR System Capital Costs	**$23,309**
Replacement SCR Catalyst Element Capital Costs		
SCR Catalyst Element	Includes catalyst element, catalyst housing, and related installation costs	$50,000
Annualized SCR Catalyst Element Capital Costs (10 years, 10%)	0.163 x SCR Catalyst Element Capital Costs	**$8,150**
Annual Cost for New LB IC Engine with New SCR System	Annualized Engine Capital Cost + Annualized SCR System Cost	**$72,209**

Item	Assumptions/Methodology	Cost
Annual Cost for New SCR Catalyst Element	Annualized SCR Catalyst Element Capital Cost	**$8,150**

The emissions reductions are calculated below:

BHP = 4,157 bhp
HR = 4,000 hours/year (hr/yr)
EF1 = 0.142 g-NOx/bhp-hr (equivalent to 11 ppmvd NOx at 15% O2; assuming 33% mechanical efficiency)
EF2 = 0.063 g-NOx/bhp-hr (equivalent to 5 ppmvd NOx at 15% O2; assuming 33% mechanical efficiency)
Load Factor (LF) = 0.8
CF = 453.59 grams/pound (g/lb)

Current NOx = (BHP x HR x EF1 x LF) / (CF)
= (4,157 bhp x 4,000 hr/yr x 0.142 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 4,164 lb-NOx/year

Potential NOx = (BHP x HR x EF2 x LF) / (CF)
= (4,157 bhp x 4,000 hr/yr x 0.063 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 1,848 lb-NOx/year

Potential Emissions Reduction = Current NOx – Potential NOx
Potential Emissions Reduction = (4,164 - 1,848 lb) x (1 ton / 2,000 lb)
Potential Emissions Reduction = 1.16 tons/year

<u>**Cost Effectiveness (Lean-Burn "Not Listed Above", 5 ppmv)**</u>
The cost effectiveness is the added cost, in dollars per year, of the control technology, divided by the emissions reductions achieved, in tons per year. Based on the calculations above, the cost effectiveness of retrofitting or replacing current limited use lean-burn spark-ignited engines is as follows:

- <u>New lean-burn engine with new SCR system</u>: $62,249/ton of NOx reduced
- <u>New SCR Catalyst Element</u>: $7,026/ton of NOx reduced

Rich Burn "Not Listed Above"

During the rule amendments in 2011, the District identified categories of non-ag spark-ignited engines and corresponding NOx emission limits that took into account the differences between engines used for different applications. The "not listed above" category accounts for all engines other than those that fit into a specific named category and provides a NOx emissions limit of 11 ppmv for rich-burn engines.

Through complying with the current rule limit, engines in this category have already achieved significant NOx emissions reductions through use of advanced emissions controls such as a NSCR systems. When evaluating the feasibility of achieving additional reductions to meet a NOx emissions limit of 7 ppmv, an engine will already be equipped with the major components for the required NSCR system like three-way catalyst (three-way catalyst), air-to-fuel ratio controller, sensors, and ignition system. However, the existing three-way catalyst will not likely be able to achieve further NOx reductions and will need to be replaced. It is likely that the other components like air-to-fuel ratio controller and sensors would also need to be replaced since the existing components may be worn or even outdated (e.g., an older, single-point air-to-fuel ratio controller may not be able to consistently maintain the much lower NOx limit as well as a more modern and advanced multi-point controller). Thus, the replacement of the entire NSCR system may be needed. For the purposes of evaluating both feasible scenarios, the following analysis includes retrofitting an existing engine with a replacement catalyst element and retrofitting an existing engine with an entirely new NSCR system.

Table C-12 Annual Cost for Installing a New Rich-Burn Engine with an NSCR System

Item	Assumptions/Methodology	Cost
Average Engine Power Rating	162 bhp	n/a
Annual Operation	4,000 hr	n/a
New NSCR System Capital Costs		
NSCR System	Includes: NSCR catalyst element, air-to-fuel ratio controller, sensors, ignition system, and installation equipment and costs	$21,000
Annualized NSCR System Capital Costs (10 years, 10%)	0.163 x Total NSCR System Capital Costs	**$3,423**
New NSCR Catalyst Element Capital Costs		
New NSCR System	Includes: NSCR catalyst element and installation	$5,000
Annualized Catalyst Capital Cost (10 years, 10%)	0.163 x New NSCR Catalyst Element	**$815**
Annual Cost for Retrofit of RB Engine with New NSCR System	Annualized NSCR System Capital Cost	**$3,423**
Annual Cost for Retrofit of RB Engine with New NSCR Catalyst Element	Annualized Three-Way Catalyst Element Capital Cost	**$815**

The emissions reductions are calculated below:

BHP = 162 bhp
HR = 4,000 hours/year
EF1 = 0.142 g-NOx/bhp-hr (equivalent to 11 ppmv at 30% HHV mechanical efficiency)

EF2 = 0.089 g-NOx/bhp-hr (equivalent to 7 ppmv at 30% HHV mechanical efficiency)
Load Factor (LF) = 0.80
CF = 453.59 grams/pound

Current NOx = (BHP x HR x EF1 x LF) / (CF)
= (162 bhp x 4,000 hr/yr x 0.142 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 162 lb-NOx/year

Potential NOx = (BHP x HR x EF2 x LF) / (CF)
= (162 bhp x 4,000 hr/yr x 0.089 g-NOx/bhp-hr x 0.8) / (453.59 g/lb)
= 102 lb-NOx/year

Potential Emissions Reduction = Current NOx – Potential NOx
Potential Emissions Reduction = (162 - 102 lb) x (1 ton / 2,000 lb)
Potential Emissions Reduction = 0.03 tons/year

Cost Effectiveness (Rich-Burn "Not Listed Above", 7 ppmv)
The cost effectiveness is the added cost, in dollars per year, of the control technology, divided by the emissions reductions achieved, in tons per year. Based on the calculations above, the cost effectiveness of replacing current engines in the rich-burn "not listed above" category is as follows:

- Retrofitted rich-burn engine with new NSCR system: $114,100/ton of NOx reduced
- Retrofitted rich-burn engine with new three-way catalyst element: $27,167/ton of NOx reduced

NOx Emission Limitation for Agricultural Operation (AO) Spark-Ignited Engines:

Feasibility Considerations: AO Spark-Ignited Engines
Over the past decade, AOs have invested significant capital to retrofit and replace thousands of irrigation pump and other engines reducing emissions by over 80% in this category, and continue to do so as emission limitations and associated compliance deadlines materialize under Rule 4702. In addition to the high cost-effectiveness and potential technical infeasibility associated with retrofitting or replacing existing AO spark ignited engines, requiring additional costly controls on existing AO engines is economically challenging and potentially infeasible.

Retrofitting existing spark-ignited engines poses several challenges that are not present when installing new, replacement engines. The District had to overcome many obstacles and challenges in retrofitting existing AO engines when the District adopted its current emission limit of 90 ppm and has worked closely with AO engine owners and operators and control system manufacturers to ensure compliance with this stringent emission limit. Efforts to ensure compliance with the current rule limit are continuing today. Lowering the emission limit from 90 ppmv 11 ppm, results in even greater challenges for existing engines to consistently meet because of the much lower tolerance for being out of compliance. These challenges are outlined in the following list. Details are provided below:

Challenges with retrofitting existing engines:

1. Engine power losses from adding controls
2. Existing engines may require overhaul
3. Existing engines cannot meet lower emissions levels due to narrower margin of compliance
4. Control systems must be custom designed
5. Errors generated during control system installation
6. Retrofit controls can damage an engine
7. Engine can damage a control system
8. Compliance costs
9. Engines operated in remote locations

1. Engine power losses from adding controls

An engine is chosen based on its ability to provide the required power output at a reasonable engine speed (rpm) that will not over-stress the engine over its expected service life. Add-on emission control systems result in additional loads that the engine may not have been originally designed to accommodate.
In addition, due to the extreme drought conditions, engine owners and operators have needed to increase the power output for well pump engines as the water table has dropped. As the engines work harder to pump water, there is less power output available to accommodate emission control systems.

2. Existing engines may require overhaul

The engines in use at AOs have been in service for many years, even decades, and are heavily worn. A worn engine can burn oil, leak fluids, and run rough. For an uncontrolled engine, some of the effects of engine wear do not have a major effect on the engine's ability to do its job (e.g. pumping water). However, the operation of a catalytic emission control system requires that the engine be operated consistently smooth. An expensive major engine overhaul or rebuild would be necessary to ensure smooth engine operation prior to installing a catalytic emission control system. Many AOs do not have the resources (e.g., staff, experience, technical training, etc.) to complete an engine overhaul or rebuild without outside assistance. Meeting more stringent/lower emission standards increases the need for the engine to operate properly.

3. Existing engines cannot meet lower emissions levels due to narrower margin of compliance

As emission limits are lowered, there is a narrower margin of compliance and proper engine operation becomes more critical. AOs in the District have to constantly ensure that their engine is properly maintained and within all the appropriate specifications to ensure compliance with the current emission limit, more so than newer engines. The lower emissions levels will result in additional stresses on the engine and increased maintenance and monitoring efforts that result from operating a retrofitted engine. Even then, due to the age of the engine and based on engine not appropriately designed for additional add-on systems and the associated loads, engines will not be able to meet the lower limits.

4. Control systems must be custom designed

For proper control system design, the engine condition, make, model, power output, and exhaust gas flow rate and temperature must be considered. There are not universal, off-the-shelf, one size-fits-all systems available for purchase. Control system design also assumes that an engine is operating properly and smoothly per the engine manufacturer's specifications. To ensure proper operation of the control system, an engine may need to be overhauled or rebuilt prior to installation of the control system.

A common problem with many retrofit emission control systems is installation of a system on an engine that is not operating smoothly or to engine manufacturer specifications. Installing a control system on a rough running engine will result in poor control system operation and eventually system and engine damage. Proper system design and engine operation is more important as emission limits are lowered since the margin of compliance will be much less.

5. Errors generated during control system installation

Site conditions like gas supply pressure can cause an existing engine to operate rough. If site issues are not addressed prior to installation of a control system, the control system will not operate correctly. An installer may attempt to correct rough engine operation by making the combustion more fuel rich; however, this technique will not provide lasting results and will cause accelerated engine and control system wear and eventually failure. An emission control system that is designed to meet lower emission limits will require a larger catalyst element which will be more expensive to replace if permanently damaged.

6. Retrofit controls can damage an engine

For proper control of exhaust pollutants, a catalyst must be operated at a certain temperature range that is higher than normal exhaust temperatures. Additional fuel is often injected into the engine with the intent that the additional fuel will pass through the combustion chamber and ignite in the exhaust system prior to the catalyst (the high catalyst temperature ignites the fuel). This extra fuel results in higher engine operating temperatures since some of the extra fuel is combusted during normal engine combustion. The increased engine temperature leads to accelerated engine wear and reduced engine reliability. Due to wear and older design, increased combustion temperatures lead to engine failure and permanent engine damage.

7. Engine can damage a control system

An existing, worn engine can burn oil and run rough. Oil in the exhaust stream will foul/mask a catalyst which will result in reduced emission control efficiency and likely permanent damage to a catalyst element. The air-fuel ratio controller will attempt to adjust engine operation (e.g., injecting more fuel) to keep the control system operating within the specified parameters; however, adjusting engine operation will not correct a fouled catalyst. Continued operation with a damaged catalyst will lead to permanent catalyst damage. An emission control system that is designed to meet lower emission limits will require a larger catalyst element which will be more expensive to replace if permanently damaged and this cycle will be repeated further adding to the cost.

8. Compliance costs
Unlike many industries, AOs compete on an international basis and cannot pass increased production costs on to consumers. AOs must absorb the compliance costs associated with lower emission standards, for example: retrofit and replacement costs; additional maintenance costs; additional monitoring costs; and additional testing costs. These additional regulatory costs put them at an economic disadvantage to their competitors.

9. Engines operated in remote locations
AO spark-ignited engines are generally located in rural, hard to access areas with minimal oversight since AOs have limited resources and staffing. With seasonal labor and minimal year-round staffing, it is difficult for AOs to provide the frequent and complex maintenance required for retrofitted or new engines equipped with advanced emission controls. Lower emission limits are achieved only through well maintained engines and control systems. Lower emissions limits lead to increased maintenance and monitoring efforts. The oil production industry is the only other major industry in the Valley that has IC engines located in remote locations; however, with the highly technical nature of oil production and refining as compared to agricultural production and additional economic resources, it is feasible for the oil and gas production industry to hire qualified staff dedicated to maintaining and operating IC engines and other equipment on-site.

Retrofitting AO engines with emission control systems to meet increasingly stringent emission limits poses unique challenges that are not applicable when installing replacement engines. Based on the challenges outlined above, meeting 25 ppm or even 11 ppm with existing AO engines is not practicable. The additional maintenance, monitoring, and testing, along with the cost of rebuilding engines and the cost of the emission control system, may even be more costly than installing a replacement engine.

Despite the technological feasibility issues associated with retrofitting or replacing existing AO spark-ignited engines, the District evaluated the cost effectiveness and feasibility of achieving an 11 ppmv NOx emission limit for the following scenarios:

- Installing a new IC lean-burn engine with SCR as a replacement for an existing unit
- Retrofitting an existing lean-burn IC engine with SCR

- Installing a new rich-burn engine with a three-way catalyst system as a replacement for an existing unit

The District gathered costs information from District's Permits database, IC engine manufacturers, emission control system manufacturers and suppliers, and agricultural industry representatives to determine the costs in the analyses below.

AO Lean-Burn Engines (11 ppmv)

When evaluating the ability to lower NOx emissions to 11 ppmv, an agricultural operator can either retrofit the existing lean-burn IC engine with a selective catalytic reduction (SCR) system or install a new lean-burn engine with an SCR system.

Table C-13 Annual Costs for Retrofitting an Existing AO Lean-Burn Engine with SCR and Installing a New AO Lean-Burn Engine with SCR

Item	Assumptions/Methodology	Cost
Average Engine Power Rating	241 brake horsepower (bhp)	n/a
Annual Operation	2500 hours (hr)	n/a
Capital Costs (Engine)		
New Engine Cost (without SCR)	Includes: engine, freight, installation, start-up, additional equipment (belt guards, fuel connection, etc.), and tax	$109,480
Annualized Engine Capital Costs (10 years, 10%)	0.163 x New Engine Cost	**$17,845**
SCR Equipment & Installation Costs		
Total SCR Equipment and Installation Costs	$100,000 per engine, includes catalyst element, urea injection system, and related installation equipment and costs	$100,000
Annualized SCR Capital Costs (10 years, 10%)	0.163 x Total SCR Capital Costs	**$16,300**
Annual Operating and Maintenance Costs (SCR)		
Annual Reagent (urea) Cost	$2.5 per gallon; 0.3 gallon/hr Cost = $2.5/gal x 0.3 gal/hr x 2,500 hr	$1,875
Annual Increase in Fuel Cost (due to drop in fuel efficiency with SCR)	Fuel usage = 2,044.5 standard cubic feet per hour (scf/hr) Fuel cost (per 1,000 scf) = $8.39 Fuel cost (per hour) = (2,044.5 scf/hr x $8.39) / 1,000 scf Fuel cost (per year) = hourly cost x 2,500 hr 2.5% drop in fuel efficiency Added Fuel Cost = Annual fuel cost x 2.5%	$1,072
Annual Electricity Cost (for compressor)	3 hp compressor = 2.24 kW power rating Electricity rate for AO = $0.18462/kW-hr Hourly electricity cost = 2.24 kW x $0.18462/kW-hr Annual electricity cost = hourly cost x 2,500 hr	$1,034

Item	Assumptions/Methodology	Cost
Annual Catalyst Cost	Life of catalyst = 5 years Cost per catalyst = $5,000 Catalyst costs for 10 years = $5,000 x 2 Annualized cost = $10,000 x 0.163	$1,630
Annual Maintenance Cost	Maintenance = $0.018 per bhp per hour of operation Annual cost = $0.018 x 241 bhp x 2,500 hr	$10,845
Annual Operating & Maintenance (O&M) Costs	Annual O&M = Annual Reagent Cost+ Annual Increased Fuel Cost + Annual Electricity Cost + Annual Catalyst Cost + Annual Maintenance Cost	**$16,456**
Annual Cost for Retrofit of LB Engine with SCR	Annualized SCR Capital Cost + Annual O&M Cost	**$32,756**
Annual Cost for New LB Engine with SCR	Annualized Engine Capital Cost + Annualized SCR Capital Cost + Annual O&M Cost	**$50,601**

The emissions reductions are calculated below:

BHP = 241 bhp
HR = 2,500 hours/year (hr/yr)
EF1 = 2.126 g-NOx/bhp-hr (equivalent to 150 ppmv at 30% mechanical efficiency)
EF2 = 0.156 g-NOx/bhp-hr (equivalent to 11 ppmv at 30% mechanical efficiency)
Load Factor (LF) = 0.80
CF = 453.59 grams/pound (g/lb)

Current NOx = (BHP x HR x EF1 x LF) / (CF)
= (241 bhp x 2,500 hr/yr x 2.126 g-NOx/bhp-hr x 0.80) / (453.59 g/lb)
= 2,259 lb-NOx/year

Potential NOx = (BHP x HR x EF2 x LF) / (CF)
= (241 bhp x 2,500 hr/yr x 0.156 g-NOx/bhp-hr x 0.80) / (453.59 g/lb)
= 166 lb-NOx/year

Potential Emissions Reduction = Current NOx – Potential NOx
Potential Emissions Reduction = (2,259-166 lb) x (1 ton / 2,000 lb)
Potential Emissions Reduction = 1.05 tons/year

Cost Effectiveness (AO Lean-Burn, 11 ppmv)

The cost effectiveness is the added cost, in dollars per year, of the control technology, divided by the emissions reductions achieved, in tons per year. Based on the calculations above, the cost effectiveness of retrofitting or replacing current AO lean-burn spark-ignited engines is as follows:

- Retrofitted lean-burn engine with SCR: \$31,196/ton of NOx reduced[78]
- New lean-burn engine with SCR: \$48,191 of NOx reduced

AO Rich-Burn Engines (11 ppmv)

When evaluating the ability to lower NOx emissions to 11 ppmv, an agricultural operator can install a new rich-burn engine with 3-way catalyst.

Table C-14 Annual Cost for Installing a New AO Rich-Burn Engine with a 3-way Catalyst

Item	Assumptions/Methodology	Cost
Average Engine Power Rating	256 bhp	n/a
Annual Operation	2,500 hr	n/a
Total Capital Costs		
New Engine Cost	Includes: engine with 3-way catalyst, freight, installation, and tax	\$95,000
Annualized Engine Capital Costs (10 years, 10%)	0.163 x New Engine Cost	**\$15,485**
Annual Operating and Maintenance Costs (SCR)		
Annual Added Fuel Cost (due to drop in fuel efficiency with catalyst)	Fuel usage = 2,171.7 scf/hr Fuel cost (per 1,000 scf) = \$8.39 Fuel cost (per hour) = (2,171.7 scf/hr x \$8.39) / 1,000 scf Fuel cost (per year) = hourly cost x 2,500 hr Assume 2.5% drop in fuel efficiency Added Fuel cost = Annual fuel cost x 2.5%	\$1,139
Annual Catalyst Cost	Life of catalyst = 5 years Cost per catalyst = \$5,000 Catalyst costs for 10 years = \$5,000 x 2 Annualized Catalyst Cost = \$10,000 x 0.163	\$1,630
Annual Maintenance Cost	Maintenance = \$0.018 per bhp per hour of operation Annual Maintenance Cost = \$0.018/bhp-hr x 256 bhp x 2500 hr	\$11,520
Annual Operating & Maintenance (O&M) Costs	Annual O&M = Annual Added Fuel Cost + Annual Catalyst Cost + Annual Maintenance Cost	**\$14,289**
Annual Cost for New RB Engine with 3-way	Annualized Engine Capital Cost + Annual O&M Cost	**\$29,774**

[78] Due to the remoteness of these engines, it is likely that most sites will not have existing electricity to power the electrical compressor for the urea injection system. The costs provided in this section do not include costs to bring electricity to the site. Overall costs will be significantly higher if this additional cost is added.

The emissions reductions are calculated below:

BHP = 256 bhp
HR = 2,500 hours/year
EF1 = 1.276 g-NOx/bhp-hr (equivalent to 90 ppmv at 30% HHV mechanical efficiency)
EF2 = 0.156 g-NOx/bhp-hr (equivalent to 11 ppmv at 30% HHV mechanical efficiency)
Load Factor (LF) = 0.80
CF = 453.59 grams/pound

Current NOx = (BHP x HR x EF1 x LF) / (CF)
= (256 bhp x 2,500 hr/yr x 1.276 g-NOx/bhp-hr x 0.80) / (453.59 g/lb)
= 1,440 lb-NOx/year

Potential NOx = (BHP x HR x EF2 x LF) / (CF)
= (256 bhp x 2,500 hr/yr x 0.156 g-NOx/bhp-hr x 0.80) / (453.59 g/lb)
= 176 lb-NOx/year

Potential Emissions Reduction = Current NOx – Potential NOx
Potential Emissions Reduction = (1,440-176 lb) x (1 ton / 2,000 lb)
Potential Emissions Reduction = 0.63 tons/year

Cost Effectiveness (AO Rich-Burn, 11 ppmv)

The cost effectiveness is the added cost, in dollars per year, of the control technology, divided by the emissions reductions achieved, in tons per year. Based on the calculations above, the cost effectiveness of replacing current AO rich-burn engines is as follows:

- New rich-burn engine with a 3-way catalyst to meet 11 ppmv: $47,260/ton of NOx reduced

AO Spark-Ignited Engines (Replace with Electric Motors or Tier 4-Equivalent Engines through Incentive/Regulatory Measure)

As demonstrated above, the replacement of agricultural operation rich-burn and lean-burn engines with new engines and control systems is not cost-effective or feasible. Building on the prior successful model of pursuing transition to advanced engine technologies through an incentive-based approach, it may be possible to achieve additional cost-effective reductions through the transition of spark-ignited to electric motors where access to electricity is available, or Tier 4-equivalent engine technologies (0.30 g/hp-hr, ~20 ppmv NOx). This approach would rely on strong incentives for both the motor/engine costs and electrical infrastructure, outreach through a collaborative effort with affected sources, USDA-NRCS, and other stakeholders and would potentially be coupled with a regulatory backstop to encourage participation. In partnership with agricultural stakeholders, the District has been in discussions with utilities to explore the potential of developing enhance rate structures to further incentivize the transition to electrification where feasible.

AO Compression-Ignited Engines (Replace with Electric Motors or Tier 4-Equivalent Engines through Incentive Measure)

Working closely with the agricultural community, publically owned utilities, USDA-NRCS, and other stakeholders, emissions from agricultural compression-ignited engines have been reduced by up to 80% through a whole-scale transition from uncontrolled Tier 0 engines to lower-emitting Tier 1 and Tier 2 engines, and then again through transition to even lower-emitting Tier 3, Tier 4, and electric engines/motors. While the current stringent requirements satisfy all federal requirements for RACM, BACM, and MSM, additional reductions may be possible through an incentive-based approach. Building on the prior successful model of pursuing transition to advanced engine technologies through an incentive-based approach, it may be possible to achieve additional cost-effective reductions through the transition of compression-ignited engines to electric motors where access to electricity is available, or Tier 4-equivalent engine technologies (0.30 g/hp-hr, ~20 ppmv NOx). This approach would rely on strong incentives for both the motor/engine costs and electrical infrastructure, and outreach through a collaborative effort with affected sources, USDA-NRCS, and other stakeholders. In partnership with agricultural stakeholders, the District has been in discussions with utilities to explore the potential of developing enhanced rate structures to further incentivize the transition to electrification where feasible.

SOx and PM limitations

Rule 4702 contains stringent requirements requiring the combustion of Public Utilities Commission (PUC) quality natural gas, or other equivalent ultra-low sulfur fuels, and diesel engines subject to Rule 4702 are required to be EPA Tier 3 or Tier 4 certified, depending on the size of the engine and the annual operating hours. EPA Tier 3 and 4 certifications require the units to meet low PM limits and Tier 4 engines are required to meet even lower PM emissions through the use of particulate filters. Given the low PM2.5 and SOx emissions from IC engines and existing rule requirements, the District determined that no further requirements were needed to address PM2.5 and SOx emissions.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for emissions from internal combustion engines. As demonstrated above, Rule 4702 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

While the District meets or exceeds RACM, BACM, and MSM requirements for this source category, given the enormity of reductions needed to demonstrate attainment with the latest PM2.5 standards, the District will pursue the following potential opportunities that are projected to provide 1.4 tons NOx per day of additional emissions reductions towards the District's aggregate plan commitment:

- Non-Agricultural IC Engines: Work with affected operators to further reduce NOx emissions from non-ag IC engines to the extent that such controls are technologically achievable and economically feasible. Technologies evaluated with the potential to further reduce emissions include the installation of 3-way catalytic reduction for rich-burn IC engines and selective catalytic reduction for lean-burn IC engines. While the analysis above shows that many control technologies are not cost-effective, potential emission reduction opportunities for further evaluation include:
  - Rich Burn Engines ("not listed above" category): Lower existing limit of 11 ppmv to as low as 7 ppmv
  - Lean Burn Engines ("not listed above" category): Lower existing limit of 11 ppmv to as low as 5 ppmv
  - Limited Use Rich/Lean Burn: Lower existing limits of 25 and 65 ppmv to as low as 11 ppmv

- Agricultural IC Engines: Work with agricultural sources to further reduce NOx emissions through incentive-based/regulatory approach as technologically and economically feasible. While the analysis above demonstrates that the various control technologies are generally not cost-effective without financial assistance, and may not be technologically feasible for remote ag installations, potential emission reduction opportunities for further evaluation include:
  - Replacement of spark-ignited agricultural engines with electric motors where access to electricity is available, or Tier 4-equivalent engine technologies through incentive-based approach coupled with regulatory backstop to encourage participation.
  - Replacement of Tier 3 compression-ignited agricultural engines with electric motors where access to electricity is available, or Tier 4-equivalent engine technologies through incentive-based approach to achieve additional emissions reductions where cost-effective.

The proposed commitments by the District and CARB will each achieve an aggregate emission reduction of direct PM2.5 and NOx. While the commitments include estimates of the emission reductions from each individual measure, final measures as proposed for adoption into the state implementation plan (SIP) may provide more or less emission reductions. The aggregate commitment will guarantee that the total emission reductions will be achieved to attain each NAAQS as expeditiously as practicable.

C.18 Rule 4703 (NOx Emissions from Stationary Gas Turbines)

Discussion

The provisions of this rule are applicable to all stationary gas turbine systems, which are subject to District permitting requirements, and with electrical generation ratings equal to or greater than 0.3 megawatt (MW) or a maximum heat input rating of more than 3 million British Thermal Units per hour (MMBtu/hr), and that are used for the generation of electrical power. The purpose of this rule is to limit NOx emissions from these stationary gas turbines.

Rule 4703 was adopted on August 18, 1994. Since its adoption, the rule has been amended six times. The latest rule amendment in September 2007 strengthened the rule by establishing more stringent NOx limits for existing stationary gas turbines. EPA finalized approval for Rule 4703 on October 21, 2009 and deemed this rule as being at least as stringent as established RACT requirements. NOx emissions have been controlled by over 86% for this source category.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	1.30	1.13	1.16	1.12	1.12	1.13	1.14	1.15	1.15
NOx	3.29	2.89	2.98	2.87	2.89	2.92	2.94	2.95	2.97
	Winter Average - Tons per day								
PM2.5	1.29	1.12	1.15	1.11	1.12	1.13	1.13	1.14	1.15
NOx	3.20	2.82	2.90	2.80	2.82	2.85	2.87	2.88	2.90

Source Category

The requirements of rule 4703 affect owners and operators of stationary gas turbine systems used to pump, compress, generate electricity, or perform other tasks. The four major industry groups using this type of equipment are oil and gas production, utilities, manufacturing, and government.

In complying with this rule, all affected entities are required to control NOx and CO emissions by installing approved emissions control devices. Early in the rule development process, the District identified four different emissions control technologies that could be used to achieve proposed limits for stationary gas turbines. Of the four options, three mainly control NOx emissions, while the other one controls CO emissions. The three NOx control technologies are:

- Diluent (water or steam) injection systems,
- Dry, low-NOx, and
- Selective Catalytic reduction

Emissions limits vary by size, cycle, annual operating hours, and fuel type. The emissions limits in this rule by category are summarized in the tables below.

HOW DOES DISTRICT RULE4703 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There are no EPA CTG requirements for this source category.

Alternative Control Techniques (ACT)

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

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.

New Source Performance Standards (NSPS)

- 40 CFR 60 Subpart GG (Standards of Performance for Stationary Gas Turbines)

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.

National Emissions Standards for Hazardous Air Pollutants (NESHAP)/Maximum Achievable Control Technology (MACT)

- 40 CFR 63 Subpart YYYY (National Emission Standards for Hazardous Air Pollutants for Stationary Combustion Turbines)

40 CFR 63 Subpart YYYY was last amended on April 20, 2006; however, this NESHAP only contains emission limits and regulations to reduce formaldehyde emissions. Formaldehyde is an organic compound which is most closely related to VOC emissions. This control measure analysis does not apply to VOC emissions. Therefore, the requirements of Subpart YYYY have not been included as a part of this control measure source category evaluation.

State Regulations
There are no state regulations applicable to this source category.

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

There are no analogous rules for this source category in SMAQMD

BAAQMD

- BAAQMD Regulation 9 Rule 9 (Nitrogen Oxides from Stationary Gas Turbines *(Amended December 6, 2006)*

  The District evaluated the requirements contained within BAAQMD's Rule 9-9 and found no requirements that were more stringent than those already in Rule 4703.

	SJVAPCD	BAAQMD
Applicability	Gas turbines ≥ 0.3 MW or a maximum heat input rating of 3 MMBtu/hr	Gas turbines ≥ 5.0 MMBtu/hr
Exemption	• 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 less than 100 hours per calendar year for maintenance and testing purposes.	• Testing of aircraft gas turbine engines for flight certification. • Gas turbines used solely for firefighting and/or flood control. • Gas turbines used solely for firefighting and/or flood control. Gas turbines rated less than 50 MMBtu/hr heat input that operate less than 877 hours in any 12-month period.
Requirements	The operator of any stationary gas turbine shall not operate a unit in such a manner that results in NO_X emissions, referenced at 15% O_2, shall not exceed the following limits:	A person shall not operate a stationary gas turbine unless NO_X emission concentrations, referenced at 15% O_2, do not exceed the following limits:
	Units Rated < 3 MW	
	Gas Fuel - 9 ppm Liquid Fuel - 25 ppm	Natural Gas - 42 ppm Refinery, Waste, or LPG - 50 ppm Non-Gaseous – 65 ppm
	Units Rated ≥ 3 MW and < 10 MW	

	• *Pipeline Gas:* Steady State Operation – 8 ppm Non-Steady State Operation – 12 ppm Liquid Fuel – 25 ppm • *< 877 hr/yr:* Gas Fuel - 9 ppm Liquid Fuel - 25 ppm • *≥ 877 hr/year and not listed above:* Gas Fuel - 5 ppm Liquid Fuel - 25 ppm	• *Units without Water Injection, Steam Injection, or Dry Low NO_X (DLN) Technology Available :* Natural Gas - 42 ppm Refinery, Waste, or LPG - 50 ppm Non-Gaseous – 65 ppm • *Units with Water Injection or Steam Injection Available :* Natural Gas - 35 ppm Refinery, Waste, or LPG - 50 ppm Non-Gaseous – 65 ppm • *Units with DLN Technology Available:* Natural Gas - 25 ppm Refinery, Waste, or LPG - 50 ppm Non-Gaseous – 65 ppm
	Units Rated ≥ 10 MW	
	• *Combined Cycle:* Gas Fuel - 5 ppm (standard) Gas Fuel – 3 ppm (enhanced) Liquid Fuel – 25 ppm • *Simple Cycle and ≥ 877 hr/yr:* Gas Fuel - 5 ppm (standard) Gas Fuel - 3 ppm (enhanced) Liquid Fuel – 25 ppm • *Simple Cycle and > 200 hr/yr and < 877 hr/yr:* Gas Fuel - 5 ppm Liquid Fuel – 25 ppm • *Simple Cycle and ≤ 200 hr/yr:* Gas Fuel - 25 ppm Liquid Fuel – 42 ppm	• *≥ 10 and < 19 MW:* Natural Gas - 15 ppm Refinery, Waste, or LPG 15 ppm Non-Gaseous – 42 ppm • *≥ 19 and < 40 MW:* Natural Gas - 9 ppm Refinery, Waste, or LPG 9 ppm Non-Gaseous – 25 ppm • *≥ 40 MW:* Natural Gas - 5 ppm Refinery, Waste, or LPG 9 ppm Non-Gaseous – 25 ppm

SCAQMD

- SCAQMD Rule 1134 (Emissions of Oxides of Nitrogen from Stationary Gas Turbines) *(Amended August 8, 1997)*

  The District evaluated the requirements contained within SCAQMD's Rule 1134 and found that overall rule 4703 is more stringent than SCAQMD Rule 1134.

	SJVAPCD	SMAQMD
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
Exemption	• 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 less than 100 hours per calendar year for maintenance and testing purposes.	• Emergency standby units used to provide electrical power, water pumping for flood control or firefighting, potable water pumping, or sewage pumping provided the following are met: - Maintenance operation shall not exceed 100 hr/yr, and - Total operation of the unit shall be limited to 200 hr/yr, and - Operation of the unit shall not be for supplying power to a serving utility for distribution on the grid, and - Operation of the unit for other than maintenance purposes shall be limited to emergency situations only. • Laboratory units used in research and testing for the advancement of gas turbine technology.
Requirements	The operator of any stationary gas turbine shall not operate a unit in such a manner that results in NO_X emissions, referenced at 15% O_2, shall not exceed the following limits:	A person shall not operate a stationary gas turbine unless NO_X emission concentrations, referenced at 15% O_2, do not exceed the following limits:
	Units Rated < 3 MW	
	Gas Fuel - 9 ppm Liquid Fuel - 25 ppm	Gas Fuel – 42.0 ppm Liquid Fuel – 65.0 ppm
	Units Rated ≥ 3 MW and < 10 MW	

	• *Pipeline Gas:* Steady State Operation – 8 ppm Non-Steady State Operation – 12 ppm Liquid Fuel – 25 ppm • *< 877 hr/yr:* Gas Fuel - 9 ppm Liquid Fuel - 25 ppm • *≥ 877 hr/year and not listed above:* Gas Fuel - 5 ppm Liquid Fuel - 25 ppm	• *< 877 hr/yr:* Gas Fuel – 42.0 ppm Liquid Fuel – 65.0 ppm • *≥ 877 hr/year:* Gas Fuel – 25.0 ppm Liquid Fuel – 65.0 ppm
	Units Rated ≥ 10 MW	
	• *Combined Cycle:* Gas Fuel - 5 ppm (standard) Gas Fuel – 3 ppm (enhanced) Liquid Fuel – 25 ppm • *Simple Cycle and ≥ 877 hr/yr:* Gas Fuel - 5 ppm (standard) Gas Fuel - 3 ppm (enhanced) Liquid Fuel – 25 ppm • *Simple Cycle and > 200 hr/yr and < 877 hr/yr:* Gas Fuel - 5 ppm Liquid Fuel – 25 ppm • *Simple Cycle and ≤ 200 hr/yr:* Gas Fuel - 25 ppm Liquid Fuel – 42 ppm	• *< 877 hr/yr:* Gas Fuel – 42.0 ppm Liquid Fuel – 65.0 ppm • *≥ 10 MW, no SCR:* Gas Fuel – 15.0 ppm Liquid Fuel – 42.0 ppm • *≥ 10 MW, with SCR:* Gas Fuel – 9.0 ppm Liquid Fuel – 25.0 ppm

VCAPCD

- VCAPCD Rule 74.23 (Stationary Gas Turbines) *(Amended January 8, 2002)*

  The District evaluated the requirements contained within VCAPCD's Rule 74.23 and found no requirements that were more stringent than those already in Rule 4703.

	SJVAPCD	VCAPCD
Applicability	Gas turbines rated ≥ 0.3 MW or with a maximum heat input rating of > 3 MMBtu/hr	Gas turbines rated ≥ 0.3 MW and operated on gaseous and/or liquid fuel
Exemption	• Laboratory turbines used in research and testing for the	• Laboratory units used in research and testing for the advancement of gas turbine technology.

	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 less than 100 hours per calendar year for maintenance and testing purposes.	• Units operated exclusively for firefighting and/or flood control. • Units operated less than 200 hours per calendar year. • Emergency standby units operating during either an emergency or maintenance operation. Maintenance operation is limited to 104 hours per calendar year.
Requirements	The operator of any stationary gas turbine shall not operate a unit in such a manner that results in NO_X emissions, referenced at 15% O_2, shall not exceed the following limits:	A person shall not operate a stationary gas turbine unless NO_X emission concentrations, referenced at 15% O_2, do not exceed the following limits:
	Units Rated < 3 MW	
	Gas Fuel - 9 ppm Liquid Fuel - 25 ppm	Gas Fuel – 42.0 ppm Liquid Fuel – 65.0 ppm
	Units Rated ≥ 3 MW and < 10 MW	
	• *Pipeline Gas:* Steady State Operation – 8 ppm Non-Steady State Operation – 12 ppm Liquid Fuel – 25 ppm • *< 877 hr/yr:* Gas Fuel - 9 ppm Liquid Fuel - 25 ppm • *≥ 877 hr/year and not listed above:* Gas Fuel - 5 ppm Liquid Fuel - 25 ppm	• *< 877 hr/yr:* Gas Fuel – 42.0 ppm Liquid Fuel – 65.0 ppm • *≥ 877 hr/year:* Gas Fuel – 25.0 ppm Liquid Fuel – 65.0 ppm
	Units Rated ≥ 10 MW	

	• *Combined Cycle:* Gas Fuel - 5 ppm Liquid Fuel – 25 ppm • *Simple Cycle and ≥ 877 hr/year:* Gas Fuel - 5 ppm Liquid Fuel – 25 ppm • *Simple Cycle and > 200 hr/yr and < 877 hr/yr:* Gas Fuel - 5 ppm Liquid Fuel – 25 ppm • *Simple Cycle and ≤ 200 hr/yr:* Gas Fuel - 25 ppm Liquid Fuel – 42 ppm	• *< 877 hr/yr:* Gas Fuel – 42.0 ppm Liquid Fuel – 65.0 ppm • *≥ 10 MW, no SCR:* Gas Fuel – 15.0 ppm Liquid Fuel – 42.0 ppm • *≥ 10 MW, with SCR:* Gas Fuel – 9.0 ppm Liquid Fuel – 25.0 ppm

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

The District has adopted numerous rule amendments to the turbine rule that have successfully and significantly reduced emissions from this source category. The emissions inventory for NOx from turbines has been reduced from 31.9 tpd in 1994 to 2.8 tpd in 2017. Significant emission reductions have been achieved through the implementation of the most stringent regulations in the nation for this source category and significant investments by stakeholders to implement effective and innovative emission control technologies. Given the significant efforts and investments already made to reduce emissions from this source category, there are little remaining feasible opportunities for obtaining additional emissions reductions.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for stationary gas turbines. As demonstrated above, Rule 4703 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

C.19 Rule 4901 (Wood Burning Fireplaces and Wood Burning Heaters)

Discussion

The District takes a multidimensional and proactive approach to reducing emissions in the Valley. This philosophy is especially true for reducing emissions from residential wood burning, with a combination of regulatory controls through Rule 4901, rigorous public outreach and education efforts, Check Before You Burn program, and the District's Burn Cleaner Wood Stove Change-out Program (Burn Cleaner Program). The District's approach to reducing emissions from residential wood burning empowers Valley residents to play a major role in reducing emissions at almost no increased cost, and, in many cases, with savings in heating-related energy costs. Valley residents are encouraged to transition from older, more polluting wood burning heaters and wood burning fireplaces (also commonly called open hearth fireplaces) to cleaner alternatives, by decreasing the number of allowable burn days for high polluting wood burning heaters and fireplaces while at the same time increasing the number of burn days allowed for registered clean wood burning heaters through a tiered episodic wood burning curtailment program.

Through the District's Check Before You Burn program, which is based on Rule 4901, the District has declared and enforced episodic wood burning curtailments, also called "No burn" days, since 2003. Check Before You Burn 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 three 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.

The 2003 rule amendments added episodic wood burning curtailments when air quality was forecast to be at 150 or higher on the air quality index (AQI), which is equivalent to a PM2.5 concentration of 65 $\mu g/m^3$, and added restrictions on the installation of wood burning devices in new residential developments, based on housing density. The 2008 rule amendments lowered the mandatory curtailment level to a PM2.5 concentration of 30 $\mu g/m^3$, and added an attainment plan contingency measure that would lower the wood burning curtailment level to 20 $\mu g/m^3$ if EPA were to find that the Valley did not attain the 1997 PM2.5 NAAQS in 2014.

In September 2014, the District amended Rule 4901 continuing to solidify its standing as the most comprehensive wood burning curtailment program in the nation. Amendments to Rule 4901 imposed a virtual ban on the use of dirty wood burning devices for significant portions of the winter season while allowing more burn days for Valley residents who have invested in cleaner burning devices that are 20-50 times cleaner. The enhanced Burn Cleaner program provides meaningful financial assistance to encourage Valley residents to upgrade to cleaner devices. Successful implementation not only reduces particulate emissions on "No Burn Days", but also reduces emissions on "Burn Days" as more dirty units are replaced with cleaner devices. The 2014 amendments eliminated the attainment plan contingency measure to lower the curtailment level to 20 µg/m³ because the rule now requires it for high polluting devices.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	3.26	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82
NOx	0.49	0.42	0.42	0.42	0.42	0.42	0.42	0.42	0.42
	Winter Average - Tons per day								
PM2.5	6.35	5.49	5.49	5.49	5.49	5.49	5.49	5.49	5.49
NOx	0.95	0.82	0.82	0.82	0.82	0.82	0.82	0.82	0.82

Source Category

The wood burning fireplaces and wood burning heaters source category includes emissions from wood burning fireplaces, wood burning heaters, and outdoor wood burning devices. Rule 4901 reduces emissions from this source category through wood burning curtailments in areas with natural gas service. Rule 4901 also restricts the sale and transfers of non-compliant wood burning devices, and limits the installation of wood burning devices in new residential developments.

How does District Rule 4901 compare with federal and state rules and regulations?

There are no federal EPA CTGs, ACTs, NESHAPs, or MACT guidelines for this source category.

NSPS

- 40 CFR Part 60 Subpart AAA (Standards of Performance for New Residential Wood Heaters)

EPA published in the Federal Register on March 16, 2015, and effective May 15, 2015, amendments to 40 CFR Part 60 Subpart AAA.[79] District Rule 4901 points to the NSPS for emission limits and is therefore as stringent as the newly promulgated NSPS.

The 2015 NSPS significantly lowered the certification emission limits for wood-burning heaters that are required to be certified and sets certification limits for a broader range of wood-burning heaters by removing the existing certification criteria from the 1988 version of the rule. Standards apply not only to adjustable burn rate wood heaters (the focus of the original regulation), but also to single burn rate wood heaters/stoves, pellet

[79] Standards of Performance for New Residential Wood Heaters, New Residential Hydronic Heaters and Forced-Air Furnaces. Final Rule. 80 FR 3672. https://www.gpo.gov/fdsys/pkg/FR-2015-03-16/pdf/2015-03733.pdf

heaters/stoves, and any other affected appliance as defined in revised Subpart AAA as a “room heater.”

Although they did not require EPA certification under the 1988 NSPS, 96% of pellet heaters meet the new Step 1 PM emissions limit of 4.5 grams per hour. Single burn rate wood heaters are incapable of operating at the lowest burn rates, and it is the lower burn rates that result in the highest level of PM emissions; therefore, most single burn rate wood heaters also meet the Step 1 PM emissions limit. Manufacturers of such units were not initially required to modify their design if they already met the emissions standard and will automatically be deemed as certified to meet the Step 1 emission limits.

EPA promulgated a two-step compliance approach that applies to all new adjustable burn rate wood heaters, single burn rate wood heaters and pellet heaters/stoves. Under this approach, Step 1 emission limits for these sources apply to each unit manufactured on or after the effective date of the final rule (May 15, 2015) or sold at retail on or after December 31, 2015. Step 2 emission limits for these units apply to each heater manufactured or sold at retail on or after May 15, 2020. EPA is allowing an alternative compliance option for manufacturers who choose to certify using cord wood (rather than crib wood) to meet the Step 2 limits.

Subpart AAA PM Emissions Limits

<table>
<tr><th colspan="3">2-Step, 5-Year Phase-In</th></tr>
<tr><th>Step</th><th>PM limit</th><th>Compliance deadline</th></tr>
<tr><td>1</td><td>4.5 g/hr</td><td>May 15, 2015</td></tr>
<tr><td rowspan="2">2</td><td>2.0 g/hr</td><td rowspan="2">May 15, 2020</td></tr>
<tr><td>2.5 g/hr
(Cord wood alternative compliance option)</td></tr>
</table>

State Regulations

- **Puget Sound Clean Air Agency Article 13: (Solid Fuel Burning Device Standards)**

The District evaluated the requirements contained within Albuquerque City Ordinance § 9-5 and found that District rule 4901 when evaluated holistically is more stringent.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	Puget Sound Clean Air Agency Article 13: (Solid Fuel Burning Device Standards)
	Requirement	**Requirement**
Last amended	9/18/2014	10/25/2012
Sole Source exemption	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	A residence or commercial building that has no adequate source of heat other than a solid fuel heating device and the building: i. was constructed or substantially remodeled after July 1, 1992; and ii. is outside an urban growth area, as defined in RCW 36.70A; and iii. is outside an area designated by EPA as a PM2.5 or PM10 particulate nonattainment area.
No burn Day (Nov-Feb)	Level 1 Curtailment called when PM2.5 is 20-65 µg/m^3 • Wood burning fireplace, low mass fireplace, masonry heater, outdoor wood burning device, or nonregistered wood burning heater shall not be operated • Registered wood burning heater may be operated provided it’s fired on approved fuel, maintained, operated according to manufacturer instructions, and has no visible smoke	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

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	Puget Sound Clean Air Agency Article 13: (Solid Fuel Burning Device Standards)
	Requirement	**Requirement**
	Level 2 Curtailment called when PM is >65 µg/m^3 for all Units	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 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 second 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 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.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	Puget Sound Clean Air Agency Article 13: (Solid Fuel Burning Device Standards)
	Requirement	**Requirement**
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 EPA Phase II or more stringent certification as currently enforced by NSPS at time of sale or transfer or a pellet-fueled heater exempt from certification until such time NSPS removes exemption, then it must comply with NSPS 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.	Solid fuel burning devices. 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 subsections (1) and (2): • 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 January 1, 1991, or an equivalent standard under any test methodology adopted by EPA subsequent to such date: (A) Two and one-half grams per hour for catalytic woodstoves; and (B) 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.

Requirements for non-certified units	Rule requires only EPA certified units be sold in the area.	(1) 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 fine particulate nonattainment area must remove and dispose of it or render it permanently inoperable by September 30, 2015. (2) 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 September 30, 2015. 12/12 13-8 Regulation I (3) Subsection (1) above does not apply to: (A) A person in a residence or commercial establishment that does not have an adequate source of heat without burning wood; or (B) 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. (4) 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. (b) PM10. Subsection (b) of this section is established for the sole purpose of a contingency measure for PM10 nonattainment and maintenance areas. If the EPA makes written findings that: (1) an area has failed to attain or maintain the National Ambient Air Quality Standard for PM10, and (2) 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, the use of wood stoves not meeting the standards set forth in RCW 70.94.457 shall be prohibited within the area determined by the Agency to have contributed to the violation.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	Puget Sound Clean Air Agency Article 13: (Solid Fuel Burning Device Standards)
	Requirement	**Requirement**
		This provision shall take effect one year after such a determination.
Visible emissions	A registered EPA unit may be operated if it has no visible smoke when operated under normal operating conditions may be used during a Level 1 curtailment.	A person shall not cause or allow emission of a smoke plume from any solid fuel burning device to exceed an average of twenty percent opacity for six consecutive minutes in any one-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, 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 a wood stove or fireplace; or • Coal with sulfur content less than 1.0% by weight burned in a coal-only heater. All other materials are prohibited from being burned

- **Albuquerque City Ordinance § 9-5**

The District evaluated the requirements contained within Albuquerque City Ordinance § 9-5 and found that District rule 4901 when evaluated holistically is more stringent.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	Albuquerque City Ordinance § 9-2
	Requirement	Requirement
Last amended	9/18/2014	Unknown
No Burn Season	November through February	October through February
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. This includes times of temporary service outages, as determined by the gas or electrical utility service are exempt from wood burning curtailments	The following are exempt: If the wood burning device is the sole source of heat Medical necessity of a wood burning device Low income status
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	Emergency situations such as failure of residence's primary heating system
Wood Burning Season	November through February	October through February

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	Albuquerque City Ordinance § 9-2
	Requirement	**Requirement**
No burn Day	Level 1 Curtailment called when PM2.5 is 20-65 µg/m3 • Wood burning fireplace, low mass fireplace, masonry heater, outdoor wood burning device, or nonregistered wood burning heater shall not be operated • Registered wood burning heater may be operated provided it's fired on approved fuel, maintained, operated according to manufacturer instructions, and has no visible smoke	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.
	Level 2 Curtailment called when PM is >65 µg/m3 for all Units	
Visible emissions	A registered EPA unit may be operated if it has no visible smoke when operated under normal operating conditions may be used during a Level 1 curtailment.	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

HOW DOES DISTRICT RULE 4901 COMPARE TO RULES IN OTHER AIR DISTRICTS?

There are no analogous rules for this source category in VCAPCD.

SCAQMD

- SCAQMD Rule 445 (Wood Burning Devices)

The District evaluated the requirements contained within SCAQMD Rule 445 and found that District rule 4901 when evaluated holistically is more stringent.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	SCAQMD Rule 445 (Wood Burning Devices)
	Requirement	**Requirement**
Last amended	9/18/2014	5/3/2013
Applicability	Rule 4901 applies to 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 transfers or receives a wood burning heater as part of a real property sale or transfer. Any person who installs a wood burning fireplace or wood burning heater in a new residential development.	The provisions of this rule shall apply to specified persons or businesses within the South Coast Air Basin portion of the South Coast Air Quality Management District: 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; and Any property owner or tenant that operates a wood-burning device or portable outdoor wood-burning device.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	SCAQMD Rule 445 (Wood Burning Devices)
	Requirement	**Requirement**
General Exemption	The following devices are exempt from the provisions of this rule: Devices that are exclusively gaseous-fueled. Cook stoves, as described in Code of Federal Regulations 60.531. Any burning occurring on the ground is open burning and is subject to requirements of District Rule 4103.	The provisions of this rule shall not apply to wood-fired cooking devices designed and used for commercial purposes. The provisions of paragraph (d)(2) 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 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 provisions of (d)(3) shall not apply to manufactured firelogs. The provisions of (d)(5) shall not apply to wood-based fuel intended for the cooking, smoking, or flavoring of food. The provisions of subdivision (e) shall not apply under the following circumstances: A low income household; 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 & butane are not considered natural gas)	Residential or commercial properties 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

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	**SCAQMD Rule 445 (Wood Burning Devices)**
	Requirement	**Requirement**
Sole Source exemption	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.	Residential or commercial properties where a wood-burning device is the sole source of heat; or
No burn Day **(Nov-Feb)**	Level 1 Curtailment called when PM2.5 is 20-65 µg/m3 • Wood burning fireplace, low mass fireplace, masonry heater, outdoor wood burning device, or nonregistered wood burning heater shall not be operated • Registered wood burning heater may be operated provided it's fired on approved fuel, maintained, operated according to manufacturer instructions, and has no visible smoke	No person shall operate an indoor or outdoor wood-burning device, portable outdoor wood-burning device, or wood-fired cooking device during the wood burning season when a mandatory winter burning curtailment is forecast for the specific region where the device is located if the PM2.5 is forecast to exceed 30 µg/m³; or on a basin wide basis with a forecast > 30 µg/m³ is predicted for a source receptor area containing a monitoring station that has recorded a violation of the federal 24-hour PM2.5 National Ambient Air Quality Standard for either of the two previous three-year design value periods. The design value is the three-year average of the annual 98th percentile of the 24-hour values of monitored ambient PM2.5 data
	Level 2 Curtailment called when PM is >65 µg/m3 for all units	
	Sale or transfer of wood burning heaters	

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	SCAQMD Rule 445 (Wood Burning Devices)
	Requirement	**Requirement**
Sale, resale, or installation of wood-burning devices	• New. No person shall advertise, sell, offer for sale, supply, install, or transfer a new wood burning heater unless it is EPA Phase II or more stringent certification as currently enforced by NSPS at time of sale or transfer or a pellet-fueled heater exempt from certification until such time NSPS removes exemption, then it must comply with NSPS • 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: A) USEPA Certified wood-burning heater; or B) Pellet-fueled wood-burning heater; or C) A masonry heater; or D) A dedicated gaseous-fueled fireplace
Requirements for real property	5.2.1 No person shall sell or transfer any real property which contains a wood burning heater without first assuring it complies with NSPS, is pellet-fueled, or is permanently inoperable 5.2.2 Upon the sale or transfer, the seller shall provide to the recipient, and the APCO, documentation with compliance to 5.2.1.	EPA certification requirements do not apply to: 1) Indoor or outdoor wood-burning device that is permanently installed and included in the sale or transfer of any existing development 2) 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.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	**SCAQMD Rule 445 (Wood Burning Devices)**
	Requirement	**Requirement**
Requirements for new building construction	Limitations on wood burning fireplaces or wood burning heaters in new residential developments - No wood burning fireplace in a new residential development with density >2 dwelling units per acre - No more than 2 EPA units per acre in a new residential development with density >2 dwelling units per acre - No more than 1 fireplace or EPA unit in a new residential development with density ≤2 dwelling units per acre New Residential Development: any single or multi-family housing unit, for which construction began on or after 1/1/2004. Construction began when the foundation for the structure was constructed.	No person shall permanently install a wood-burning device into any new development

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	**SCAQMD Rule 445 (Wood Burning Devices)**
	Requirement	**Requirement**
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. Alternative language, toll-free telephone number or web address for the information specified in subdivision (g) may be used, subject to Executive Officer approval. 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, 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

SMAQMD

- SMAQMD Rule 417 (Wood Burning Appliances)

The District evaluated the requirements contained within SMAQMD Rule 417 and and found the District rule 4901 when evaluated holistically is more stringent.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	**SMAQMD Rule 417 (Wood Burning Appliances)**
	Requirement	**Requirement**
Last amended	9/18/2014	10/26/2006
General Exemption	Cook stoves	Cook stoves, or Commercial products manufactured expressly for starting a fire in a wood fired appliance

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	**SMAQMD Rule 417 (Wood Burning Appliances)**
	Requirement	**Requirement**
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 EPA Phase II or more stringent certification as currently enforced by NSPS at time of sale or transfer or a pellet-fueled heater exempt from certification until such time NSPS removes exemption, then it must comply with NSPS • 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.	Effective October 26, 2007, no person shall sell, offer for sale, supply, install, or transfer a new wood burning appliance unless it is one of the following: A U.S. EPA Phase II Certified wood burning heater, A pellet-fueled wood burning heater, A masonry heater, or an appliance or fireplace determined to meet the U.S. EPA particulate matter emission standard set forth in Title 40 CFR, Part 60, Subpart AAA, and approved in writing by the Air Pollution Control Officer. No person shall advertise, sell, offer for sale, supply, install, or transfer a used wood burning appliance unless it meets the requirements of section 301.1, or has been rendered permanently inoperable All wood burning appliances shall be installed and operated according to the manufacturer's specifications. Any U.S. EPA Phase II certified wood burning appliance which has been altered, installed, or disassembled in any way not specified by the manufacturer, or is operated in any manner that would result in emissions exceeding the standards set forth in Title 40 CFR, Part 60, Subpart AAA, shall not be considered a U.S. EPA Phase II certified appliance.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	**SMAQMD Rule 417 (Wood Burning Appliances)**
	Requirement	**Requirement**
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	Appliances shall distribute public awareness information with each wood burning appliance, in the form of pamphlets, brochures, or fact sheets on the following topics: 1. Proper installation, operation, and maintenance of the wood burning appliance, 2. Proper fuel selection and use, 3. Health effects from wood smoke, and 4. Weatherization methods for the home
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	No person shall sell, offer for sale, or supply any wood which orally, or in writing, is advertised, described, or in any way represented to be “seasoned” or “dry” wood unless the wood has a moisture content of 20 percent or less by weight

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	SMAQMD Rule 417 (Wood Burning Appliances)
	Requirement	**Requirement**
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, 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 appliance: Garbage, Treated wood, Plastic products, Rubber products, Waste petroleum products, Paints and other coatings, Solvents, Coal, Glossy or colored paper, Particle board, Any other material not intended by a manufacturer for use as fuel in a solid fuel burning device.

- SMAQMD Rule 421 (Mandatory Episodic Curtailment of Wood and other Solid Fuel Burning)

The District evaluated the requirements contained within SMAQMD Rule 421 and found the District rule 4901 when evaluated holistically is more stringent.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	SMAQMD Rule 421 (Mandatory Episodic Curtailment of Wood and other Solid Fuel Burning)
	Requirement	**Requirement**
Last amended	9/18/2014	09/24/2009
General Exemption	Cook stoves	Cook stoves The provisions of this rule shall not apply to fires conducted as part of a religious ceremony. The provisions of Section 301 shall not apply to any person who has an approved Hardship Waiver for economic reasons

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	**SMAQMD Rule 421 (Mandatory Episodic Curtailment of Wood and other Solid Fuel Burning)**
	Requirement	**Requirement**
Sole Source exemption	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	The provisions of this rule shall not apply to wood burning devices that are the sole source of heat in a residence
No burn Day **(Nov-Feb)**	Level 1 Curtailment called when PM2.5 is 20-65 µg/m3 • Wood burning fireplace, low mass fireplace, masonry heater, outdoor wood burning device, or nonregistered wood burning heater shall not be operated • Registered wood burning heater may be operated provided it's fired on approved fuel, maintained, operated according to manufacturer instructions, and has no visible smoke Level 2 Curtailment called when PM is >65 µg/m3 for all Units	The requirements of this section shall be in effect during the burning season. 1) No person may have a fire or operate a wood burning device when a Mandatory Curtailment is in effect. 2) The Air Pollution Control Officer will declare a Stage 1 Mandatory Curtailment whenever he or she determines that the 24-hour average PM2.5 concentration may exceed 31 µg/m3 but is not likely to exceed 35 µg/m3. 3) The Air Pollution Control Officer will declare a Stage 2 Mandatory Curtailment whenever he or she determines that the 24-hour average PM2.5 concentration may exceed 35 µg/m3. The Air Pollution Control Officer will declare a Voluntary Curtailment whenever he or she determines that the 24-hour average PM2.5 concentration may exceed 25 µg/m3 but is not likely to exceed 31 µg/m3 Burn curtailments do not apply to U.S. EPA Phase II Certified wood burning heaters and pellet fueled wood burning heaters provided the devices do not emit visible smoke and a Stage 1 Mandatory Curtailment is in effect.

BAAQMD

- BAAQMD Regulation 6 Rule 3 (Wood-Burning Devices)

The District evaluated the requirements contained within BAAQMD Regulation 6 Rule 3 and found the District rule 4901 when evaluated holistically is more stringent.

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	**BAAQMD Rule 6-3Particulate Matter and Visible Emissions – Wood Burning Devices**
	Requirement	**Requirement**
Last amended	9/18/2014	10/21/2015
Natural gas exemption	Locations where natural gas is not available are not subject to episodic curtailments (propane & butane are not considered natural gas)	No exemption (exemption (§ 6-3-10) deleted during the 2015 amendments)
Sole Source exemption	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	Burn Bans are not applicable to any person whose **sole source of heat is an EPA certified wood-burning device that is registered** with the District per the requirements of Sections 6-3-404 and 405 and who does not have available to them a permanently-installed NG, propane, or electric heating device.
		Rental properties subject to Section 6-3-305 located in areas with NG service no longer qualify for exemption
		Any person seeking exemption under Section 6-3-110 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: **404.1** Wood heaters that are EPA certified to meet performance and emission standards of 7.5 g/hr or less **404.2** A pellet-fueled wood heater exempt from EPA certification requirements pursuant to 40 CFR 60 AAA at the time of purchase or installation
		Registration is a 5-year term

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	BAAQMD Rule 6-3Particulate Matter and Visible Emissions – Wood Burning Devices
	Requirement	**Requirement**
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. 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 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.
No burn Day (Nov-Feb)	Level 1 Curtailment called when PM2.5 is 20-65 µg/m^3 • Wood burning fireplace, low mass fireplace, masonry heater, outdoor wood burning device, or nonregistered wood burning heater shall not be operated • Registered wood burning heater may be operated provided it's fired on approved fuel, maintained, operated according to manufacturer instructions, and has no visible smoke Level 2 Curtailment called when PM is >65 µg/m^3 for all Units	35 µg/m^3 results in a Mandatory Burn Ban (all devices) • 6-3-301: No person shall operate or combust wood or solid-fuel products in any wood-burning device during a Mandatory Burn Ban

<table>
<tr><th></th><th>SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters</th><th>BAAQMD Rule 6-3Particulate Matter and Visible Emissions – Wood Burning Devices</th></tr>
<tr><th></th><th>Requirement</th><th>Requirement</th></tr>
<tr><td>Wood heater manufacturers & retailers</td><td rowspan="2">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 EPA Phase II or more stringent certification as currently enforced by NSPS at time of sale or transfer or a pellet-fueled heater exempt from certification until such time NSPS removes exemption, then it must comply with NSPS
• 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.</td><td>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
- Effective 12/31/15: certified to meet 4.5 g/hr
- Effective 5/15/2020: certified to meet 2.5 g/hr if crib tested or 2.0 g/hr if cordwood tested</td></tr>
<tr><td>Sale, resale, or installation of wood-burning devices</td><td>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</td></tr>
<tr><td>Requirements for real property</td><td>No person shall sell or transfer any real property which contains a wood burning heater without first assuring it complies with NSPS, is pellet-fueled, or is permanently inoperable

Upon the sale or transfer, the seller shall provide to the recipient, and the APCO, documentation with compliance to 5.2.1.</td><td>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</td></tr>
<tr><td>Requirements for rental properties</td><td>None</td><td>Effective 11/1/2018, 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.</td></tr>
</table>

	SJVAPCD Rule 4901 Wood Burning Fireplaces and Wood Burning Heaters	BAAQMD Rule 6-3Particulate Matter and Visible Emissions – Wood Burning Devices
	Requirement	**Requirement**
Requirements for new building construction	Limitations on wood burning fireplaces or wood burning heaters in new residential developments - No wood burning fireplace in a new residential development with density >2 dwelling units per acre - No more than 2 EPA units per acre in a new residential development with density >2 dwelling units per acre - No more than 1 fireplace or EPA unit in a new residential development with density ≤2 dwelling units per acre New Residential Development: any single or multi-family housing unit, for which construction began on or after 1/1/2004. Construction began when the foundation for the structure was constructed.	No person or builder shall install a wood-burning device in a new building construction
Requirements for remodeling a fireplace or chimney	None	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	A registered EPA unit may be operated if it has no visible smoke when operated under normal operating conditions may be used during a Level 1 curtailment.	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 Wood Burning Fireplaces and Wood Burning Heaters	BAAQMD Rule 6-3Particulate Matter and Visible Emissions – Wood Burning Devices
	Requirement	**Requirement**
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 particulate matter (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 the following: “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% (percent) 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, 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

Additional Emission Reduction Opportunities

Curtailment Level in hot-spot areas

The District hot-spot strategy involves imposing more stringent requirements on sources that contribute to elevated pollution concentrations at Hot Spot locations. This strategy focuses resources on the control measures and areas in the Valley that will be most cost-effective and most impactful towards achieving attainment. Since the District already has the toughest air regulations in place, adding to the stringency of these regulations may be cost prohibitive and technology forcing. However, strategic use of incentive dollars may provide additional cost-effective opportunities that may otherwise not be feasible. The hot-spot strategy will not include any rollback or relaxation of existing regulatory requirements, but instead will focus on new measures such as targeted use of incentive funds and regulations and reduced overall cost to all regions by achieving attainment of federal standards more expeditiously. For regions that may face more stringent future measures, added regulatory cost will be mitigated by added incentives. CARB and EPA believe the Hot Spot strategy is permissible under existing law. The District evaluated achieving further reductions through more stringent wood burning curtailment program in Hot Spot areas by lowering burn prohibitions for non-registered units from 20 µg/m³ to 12 µg/m³. Hot Spot areas include Kern County, Fresno County, and other areas as necessary to demonstrate attainment.

Enhanced levels of incentives would replace wood burning devices with only natural gas or propane units in the Hot Spot areas. The Burn Cleaner program would continue to offer the current level of incentives (see below) Valleywide. The District estimates incentive monies will be $80 million total cost with $60 million dedicated to Hot Spot areas.

Encouraging the Transition to Clean Burning Heaters through Non-Regulatory Measures

Upgrading a home’s wood burning device reduces directly emitted PM2.5 emissions on days when wood burning is allowed. By operating more efficiently, these devices can also lower the overall home heating cost. The District encourages such upgrades through its public outreach and through its Burn Cleaner Program, which provides funding to Valley residents to upgrade their current wood-burning devices and open fireplaces to natural gas or propane gas devices, to certified wood stoves or inserts, or to pellet devices. The District’s webpage[80] has more information on program eligibility and qualified devices.

There are several types of wood burning devices and device inserts available. Wood stoves, especially newer models, are generally safe and efficient devices for home heating. There are two types of wood stoves: catalytic and non-catalytic. EPA’s Phase II certified wood stoves produce only 2 to 7 grams of smoke per hour, compared to 15 to 30 grams of smoke per hour from older, uncertified devices, and in future years the EPA certified devices will emit even less.

[80] www.valleyair.org/Grant_Programs/GrantPrograms.htm#WoodStoveChangeOut

Pellet stoves are similar in appearance to wood stoves, but burn compressed pellets made of ground, dried wood and other biomass wastes. Pellet stoves are generally more expensive than wood stoves and require electricity for operation; however, they are typically more efficient than wood stoves due to the better fuel-to-air ratio in the combustion chamber.

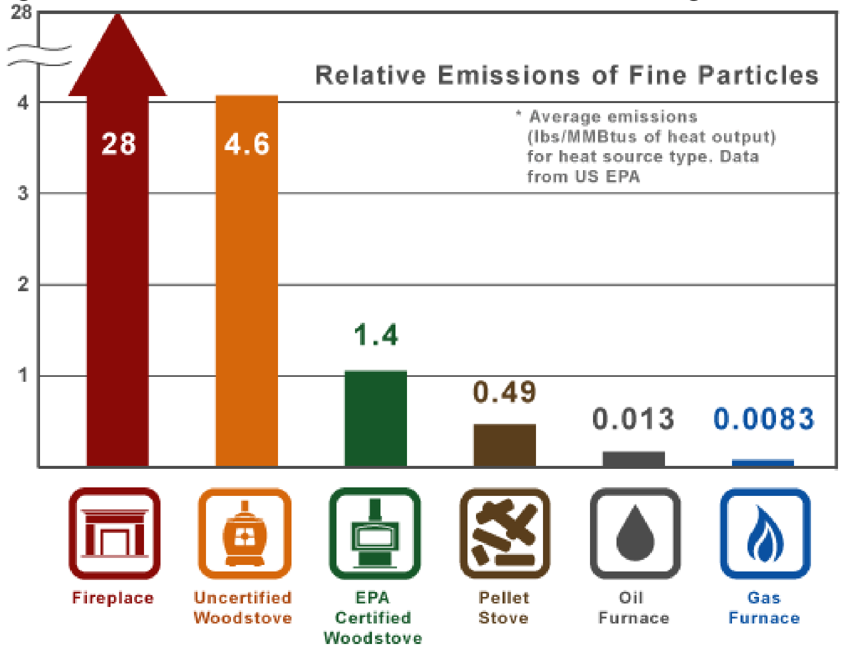
Wood burning fireplaces include traditional masonry fireplaces built into brick or stone, constructed in the home, and “low mass” fireplaces that are pre-fabricated prior to installation. Most fireplaces are not used as a primary source of heat, but serve as a secondary heating source or for ambiance. Fireplaces generate much more emissions than wood stoves or pellet stoves, but fireplace inserts are available to reduce emissions. EPA does not certify fireplaces or fireplace inserts, but does have a voluntary program for devices that meet qualifications to be considered cleaner burning than typical fireplaces and fireplace inserts. While these devices reduce emissions relative to uncontrolled fireplaces, their emissions are still relatively higher than certified wood stoves and pellet stoves.

Gas stoves and gas fireplaces burn natural gas or propane, emit very little air pollution, and require little maintenance. Gas devices are not subject to the requirements of Rule 4901, so they can be used on “No burn” days. For more information about the various types of wood burning devices available, see EPA’s Burn Wise program webpages[81].

The following figure illustrates the average PM2.5 emissions based on various heat sources.

[81] www.epa.gov/burnwise

Average PM2.5 Emissions Based on Wood Burning Heater Type[82]



Residential Wood Burning Survey

The District hired a third party company, Gomez Research, to survey Valley residents to gauge he District's current efforts, including Check Before You Burn and Burn Cleaner programs, and evaluate potential future strategies that will continue to reduce pollution from residential wood burning. Gomez Research surveyed over 1,500 Valley residents by November 2017. The survey 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 in Fresno and Kern Counties, where the Valley's peak PM2.5 air monitoring stations are located. The general sample was designed to capture a broad understanding of public awareness and perception of the District's wood burning program, while the supplemental sample was designed to elicit more information about regional wood burning control strategies. 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.

[82]EPA. (2012, November 14). *Consumers – Energy Efficiency and Wood-Burning Stoves and Fireplaces*. Retrieved from http://www.epa.gov/burnwise/energyefficiency.html.

The significant findings from the survey are categorized and summarized as follows:

A. Public Knowledge and General Beliefs about Wood Smoke

1. A total of 36% of residents who use their wood-burning devices reported that they believe wood smoke is dangerous. One-in-five Valley residents (20%) who burn do not believe wood smoke is dangerous to their health, and 8% believe it actually provides health benefits.
2. Ten percent of residents believe that someone in their household experiences health problems as a result of wood burning.
3. Findings suggest that residents who know that wood smoke is dangerous to their health tend to be English-speakers with above median incomes (greater than $50,000), although a larger sample would be needed to confirm this demographic profile statistically.

B. Presence and Use of Wood Burning Devices

1. A total of 29% of the general population surveyed reported having some type of wood burning device.
2. A total of 41% of residents living in the supplemental sample zip codes in Fresno and Bakersfield urban areas reported having some type of woodburning device. Of this population, 88% reported having an open-hearth fireplace.
3. For residents who have a wood burning device, 52% do not use their device, followed by 16% who use their device less than once a week, 14% several days a week, 9% nearly every day, and 7% once a week.
4. A total of 18% of residents living in the Fresno and Bakersfield metropolitan areas reported that they burn wood once a week or more, compared to 34% among the general population, a statistically significant difference.
5. Most residents typically burn in the evenings. Nearly two-thirds of residents typically burn in the evening (63%), followed by 17% who typically burn throughout the day, 8% who typically burn in the morning, and 7% who typically burn in the afternoon.
6. Once started, wood-burning devices in the Fresno and Bakersfield metropolitan areas were used for 3.96 hours, compared to 6.16 hours in other areas.
7. Nearly a third (32%) of all English speakers reported having a wood-burning device at their residence compared to 11% among Spanish speakers.
8. One third (33%) of residents with household incomes of $50,000 or higher were more likely to report that they had wood-burning devices compared to 23% of those below-median income.
9. Only 9% of the respondents in the general population who use a wood burning device indicated that it is their sole source of heat.

C. Awareness and Compliance with District Wood Burning Prohibitions

1. Among residents in the Fresno and Bakersfield metropolitan areas, 85% reported that they had heard of Check Before You Burn, compared to 63% among residents living elsewhere in the Valley.
2. More than half of all residents surveyed (58%) are aware of checking the burn day status using the toll-free hotline or website. Over one third (36%) of all residents were aware of email and text notifications for burn status. These figures

do not include a larger segment of the population that obtains burn status information from television, radio, and other mass media.

3. Nearly 97% of the respondents who checked for no-burn restrictions "all the time" or "most of the time" replied that they always comply with the rule. The sample size for this question was smaller and therefore the statistical significance is questionable.

D. Awareness and Interest in District *Burn Cleaner* Incentive Program

1. A total of 61% of Valley residents believe the District should provide financial assistance to encourage people to switch to cleaner-burning devices rather than institute a Valleywide ban on residential wood-burning.
2. A total of 29% of higher-income residents were aware of the Burn Cleaner incentive program, compared to 17% among lower-income residents.
3. More than 27% of English-speakers were aware of the Burn Cleaner incentive program, compared to 10% of Spanish-speakers.
4. Approximately 17% of residents with wood-burning devices would participate in the Burn Cleaner incentive program if the rebate were offered at 25%.
5. An additional 12% of residents with wood-burning devices would participate in the Burn Cleaner incentive program if the incentives was at least 50%.
6. An additional 15% of residents were willing to participate in the Burn Cleaner Burn Cleaner incentive program if a 75% rebate level was offered, for a total of 44% of residents willing to participate at or below this incentives level. Similar results were seen for the supplemental sample.

E. Public Opinion and Sentiments Related to Possible Changes to Wood Burning Program

1. Two-thirds of Valley residents (67%) believe the current burn restrictions are reasonable, followed by 14% believing current restrictions are too aggressive and should be relaxed, and 10% believing that current restrictions are too lenient.
2. Less than one third (29%) of residents surveyed in the Fresno and Bakersfield areas say they would be willing to replace their traditional devices if they could burn wood on some no-burn days, compared to 39% of residents in the rest of the Valley.
3. Only 6% of residents in the Northern Region reported that the "current restrictions don't go far enough" compared to 12% of residents in the Central Region and 13% in the Southern Region, a statistically significant difference.
4. Residents who believe wood smoke causes air pollution are more likely to support tougher burn restrictions. Among residents who recognize a correlation between wood burning and air quality, 15% reported that the current burn restrictions "don't go far enough," compared to 6% among other residents.

Burn Cleaner Incentive Program

The District's Burn Cleaner Wood Stove Change-out Program (Burn Cleaner Program) plays a key role in the success of the transition from older more polluting wood burning heaters and fireplaces to cleaner wood burning heaters. Since 2006, the Burn Cleaner Program has been helping residents overcome some of the financial obstacles in purchasing cleaner alternatives providing $20 million to replace nearly 15,000 wood burning devices throughout the Valley. There are currently more than 30 hearth retailers in the Valley that have partnered with the District to successfully implement the Burn Cleaner Program.

The Burn Cleaner Program offers multiple levels of incentive funding, increased as of the 2014-2015 wood burning season:

Table C-15 Multiple Levels of Incentive Funding for Burn Cleaner Program

NEW DEVICE TO BE PURCHASED	INCENTIVE AMOUNT
Certified wood insert/freestanding stove	Up to $1,000
Certified pellet insert/freestanding stove	Up to $1,000
Natural gas insert/freestanding stove	Up to $1,000
Any eligible device if applicant is eligible for low-income	Up to $2,500
Additional incentive towards gas device (for both Standard and Low-income)	Up to $500*

**Applies only to eligible installation costs beyond the funding amount*

Table C-C-16 Eligibility Requirements for Burn Cleaner Program

ELIGIBILITY

The old device must be located at a residence within the District boundaries. Applicants must submit an application and obtain an approved voucher from the District prior to purchasing the new device.

The following table outlines the eligibility of the new device based on the old device type.

	NEW DEVICE	(YES =	ELIGIBLE,	NO =	NOT ELIGIBLE)	
OLD DEVICE	FREESTANDING GAS STOVE	GAS INSERT OR GAS FIREPLACE1	FREESTANDING CERTIFIED PELLET STOVE	CERTIFIED PELLET INSERT	FREESTANDING CERTIFIED WOOD STOVE	CERTIFIED WOOD INSERT
Open hearth wood fireplace	Yes	Yes	Yes	Yes	Yes	Yes
Non-certified wood fireplace/insert/stove	Yes	Yes	Yes	Yes	Yes	Yes
Certified wood fireplace/insert/stove	Yes	Yes	No	No	No	No
Pellet stove/insert	Yes	Yes	No	No	No	No
Gas stove/insert, Gas fireplaces, Gas logs	No	No	No	No	No	No

New gas fireplaces must be certified as heater-rated. Gas fireplaces designed exclusively for aesthetic and decorative use are not eligible.

The District continuously re-evaluates the Burn Cleaner Program and implements enhancements to the program. In addition to increased incentive amounts, the District has also recently implemented the following enhancements:

- Reducing a substantial portion of the upfront, out-of-pocket cost of a new qualifying unit for low-income qualified applicants. The District has partnered with contracted hearth retailers to allow low-income qualified applicants to make the purchase at a reduced price by deducting the incentive amount from the invoice at the point of purchase. Allowing the incentive funding to be directly applied when purchase is made makes it more feasible for additional low-income applicants to take advantage of the program.
- Refining the low-income eligibility form to streamline the determination process and identifying the hearth retailers that provide the reduced upfront cost option.
- Program documents are now available in Spanish to further extend the outreach efforts to the local community.
- Updates to program documents to make them more user-friendly and to improve the process during the application, installation, and claim for payment request phases.

- The document submittal process has been updated to allow applications and claim for payment requests to now be emailed to the District for faster processing. Also, supplemental forms have been developed further streamline the review process and help keep the retailers and applicants informed on the status of projects.

Given this program's critical role in supporting the District's efforts to reduce the impact of residential wood burning and continued high demand in the program the District has allocated $12,821,900 in funding for the Burn Cleaner program in the District's 2018-19 Budget.

Collaboration with participating hearth retailers
As part of the District's initiative to increase the effectiveness of the Burn Cleaner program, District staff has worked closely with participating hearth retailers on outreach efforts and provided them with promotional tools, such as flyers and quick screens with information about the Program.

Public Outreach and Education
The District has an extremely successful outreach and education program with regards to residential wood burning and educating Valley residents about air quality, the effects of air pollution on the population's health, and on options they can take to reduce emissions. In the latest wood-burning season the District took part in 82 media interviews about extreme weather and wood burning.

The District's informational *Check Before You Burn* program minimizes elevated PM2.5 concentrations throughout winter. The PM2.5 air quality improvements that the Valley has experienced since the adoption of Rule 4901 have been assisted by strong multimedia outreach by the District and a resultant increase in public awareness and participation in winter District programs.

During each wood-burning season, the District Outreach staff receives hundreds of public calls and emails specific to residential wood burning. An interesting new trend has surfaced regarding public opinion, an increased number of the phone calls were in support of an outright ban on residential wood burning year-round (with the exception of residents for whom wood burning is the sole source of heat). This is attributed to heightened awareness among the general population of the deleterious effects of wood burning on public health.

Since the inception of *Check Before You Burn*, the District's complementary tools, such as the Real-time Air Advisory Network (RAAN) and the "Valley Air" app, have continued to gain in popularity. Annual public calls and website "hit" statistics, plus growth in the District's social media pages, also illustrate continued growth in wood-burning awareness. Survey results also showed an increased public awareness with eight out of ten respondents being aware of the District's *Check Before You Burn* program, 78% of whom confirmed reduced wood-burning activities as a direct result of the program.

The District also incorporates wood-burning messaging into other public outreach products, including Healthy Air Living Schools materials, Healthy Air Heroes elementary kids kits and other materials.

Multimedia Advertising Campaigns
The District's seasonal public outreach advertising campaigns are retooled each year to include timely and relevant messaging. In the past few seasons, this messaging has been delivered by the District's Governing Board members, with billboards in English and Spanish strategically placed throughout the Valley, radio and TV spots, and value-added messaging delivered by media throughout the Valley. The messaging of these campaigns reminds residents of the *Check Before You Burn* program and encourages them to take advantage of the *Burn Cleaner* grant program.

Expanding New Media Outreach
The most significant evolution of *Check Before You Burn* messaging has occurred with the expanded and accelerated use of new media for advertising. Specific wintertime campaigns have been used to reach a new audience within the District's geographic boundaries. This has proven to be a valuable way to deliver immediate messaging regarding the wood-burning rule, and the benefits of clean burning devices, in addition to providing a platform for direct, two-way interaction with the public.

Strengthening Media Partnerships
The District maintains partnerships with television, newspaper, radio, outdoor and print, as well as internet advertising. During seasonal *Check Before You Burn* campaigns, the District runs media on broadcast television stations in the Fresno and Bakersfield markets, including Spanish stations, as well as networks in four cable markets including zoned cable in Stockton, Modesto, Turlock and Manteca.

With these purchases come added value in the form of bonus spots, news sponsorships, and extra billboards and overages in outdoor messaging. Outdoor messaging is strategically placed in high-traffic areas as well as neighborhood and rural communities to ensure a wide reach in those areas where residential wood burning might be common.

The District has also found tremendous benefit from creating a versatile campaign utilizing new media trends like Pandora (digital radio) and internet/digital advertising to reach Valley audiences. Both Pandora and digital web campaign messaging allow the District to target certain listener demographics and behaviors in specific geographic areas and allow listeners to respond to the message by actively clicking through to the valleyair.org site to check their county's wood burning status.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this source category. As demonstrated above, Rule 4901 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

This measure would further reduce emissions by implementing a more stringent wood burning curtailment program as follows:

- Lower curtailment levels in targeted hot spot areas (Fresno County, Kern County except Frazier Park, other areas as necessary for attainment)
  - No burn for non-registered units at or above 12 $\mu g/m^3$
  - No burn for all devices above 35 $\mu g/m^3$
- Maintain current curtailment levels in rest of Valley
  - No burn for non-registered units at or above 20 $\mu g/m^3$
  - No burn for all devices above 65 $\mu g/m^3$
- Offer enhanced incentives in hot-spot areas
  - In hot-spot areas, incentive will only be provided for natural gas replacements
  - Enhanced levels of incentives provided in hot-spot areas to fund the full replacement of wood burning devices with natural gas units
- Continue to offer current level of incentives Valleywide in non-hot-spot areas
- Prohibit wood-burning devices in new construction (at higher elevations, only allow EPA-certified devices)
- Only allow seasoned wood to be burned
- Enhanced enforcement resources to assure continued high compliance rate
- Enhanced outreach and education efforts to increase awareness of residential wood burning health impacts and District's residential wood burning reduction strategy

C.20 Rule 4902 (Residential Water Heaters)

Discussion

Rule 4902 is a point-of-sale rule that limits NOx emissions from natural gas-fired residential water heaters. Rule 4902 was adopted on July 17, 1993 and subsequently amended in March 2009. The original rule enforced a NOx emissions limit of 40 nanograms of NOx per Joule of heat output (ng/J). The March 2009 amendments 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 water heaters. EPA finalized approval for Rule 4902 on May 5, 2010.[83]

Manufacturers have focused on combustion modifications to meet the lower NOx limit as required in other California air districts. Combustion modification systems are designed to reduce thermal NOx formation by changing the flame characteristics to reduce peak flame temperature. Combustion modification for residential water heaters is achieved by different burner designs such as low NOx and ultra-low NOx burners. 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.

Emission Inventory

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026
	Annual Average - Tons per day									
NOX	2.15	2.11	2.05	2.02	1.99	1.97	1.94	1.90	1.91	1.92
PM2.5	0.21	0.22	0.22	0.22	0.23	0.23	0.23	0.23	0.23	0.23
	Winter Average - Tons per day									
NOX	2.85	2.80	2.72	2.68	2.65	2.62	2.58	2.53	2.54	2.55
PM2.5	0.27	0.29	0.30	0.30	0.30	0.30	0.31	0.31	0.31	0.31

Source Category

Rule 4902 is a point of sale rule that 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

[83] EPA. Revisions to the California State Implementation Plan, San Joaquin Valley Unified Air Pollution Control District. Final Rule. 75 Fed. Reg. 24408. (2010, May 5). (to be codified at 40 CFR 52). https://www.gpo.gov/fdsys/pkg/FR-2010-05-05/pdf/2010-10404.pdf

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 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 is circulated through a heat exchanger in a storage tank.

How does District Rule 4902 compare with federal and state rules and regulations?

Federal Regulations
There is currently no federal guidance given for this source category under the federal CTG, Alternative Control Techniques (ACT), New Source Performance Standards (NSPS), National Emission Standards for Hazardous Air Pollutants (NESHAP), and Maximum Achievable Control Technology (MACT) requirements.

State Regulations
There are no state regulations applicable to air quality from commercial charbroiling activities.

How does district rule 4902 compare to rules in other air districts?

SCAQMD

- SCAQMD Rule 1121 (Control of Nitrogen Oxides from Residential Type, Natural Gas-Fired Water Heaters) *(September 3, 2004)*

The District evaluated the requirements contained within the SCAQMD Rule and found no requirements that were more stringent than those already in District Rule 4902.

	SJVAPCD	SCAQMD
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
Exemption	• 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.
Requirements	• No person shall manufacture for sale, distribute, sell, offer for sale, or install within the District	• No person shall manufacture for sale, distribute, sell, offer for sale, or install within SCAQMD any gas-fired water

	any PUC quality natural gas-fired: • Mobile home water heater unless it is certified to a NOx emission level of ≤ 40 ng/J. • Pool heater unless it is certified to a NOx emission level of ≤ 40 ng/J. • Water heater, excluding mobile home water heaters, instantaneous water heaters, and pool heaters, unless it is certified to a NOx emission level of ≤ 10 ng/J. • instantaneous water heater unless it is certified to a NOx emission level of ≤ 14 ng/J.	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 within SCAQMD 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

SMAQMD

- SMAQMD Rule 414 (Water Heaters, Boilers and Process Heaters Rated Less than 1,000,000 BTU Per Hour) *(March 25, 2010)*

The District evaluated the requirements contained within SMAQMD Rule and found no requirements that were more stringent than those already in District Rule 4902. Requirements for units with a rating greater than 75,000 Btu/hr but less than 2,000,000 Btu/hr are included under District Rule 4308 and have at least as stringent or more stringent limits than those in SMAQMD Rule.

	SJVAPCD	SMAQMD
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.
Exemption	• 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 of less than 75,000 Btu/hr. • Water heaters, boilers and process heaters fired with liquefied petroleum gas.
Requirements	• No person shall manufacture for sale, distribute, sell, offer for sale, or install within the District any PUC quality natural gas-fired:	A person shall only distribute, offer for sale, sell, or install within the SMAQMD a water heater, boiler or process heater with

	• mobile home water heater unless it is certified to a NOx emission level of ≤ 40 ng/J.
	• pool heater unless it is certified to a NOx emission level of ≤ 40 ng/J.
	• water heater, excluding mobile home water heaters, instantaneous water heaters, and pool heaters, unless it is certified to a NOx emission level of ≤ 10 ng/J.
	• instantaneous water heater unless it is certified to a NOx emission level of ≤ 14 ng/J.
		certified NOx and CO emissions ≤ the following limits:
		• < 75,000 Btu/hr:
		  ○ Mobile home: 40 ng/J
		  ○ All others: 10 ng/J
		• 75,000 - <400,000 Btu/hr:
		  ○ Pool/Spa: 40 ng/J
		  ○ All others: 14 ng/J
		• 400,000 to <1 million Btu/hr:
		  ○ All types: 14 ng/J NOx and 400 ppmv CO @ 3% O2

BAAQMD

- BAAQMD Regulation 9 Rule 6 (Nitrogen Oxides Emissions from Natural Gas-Fired Boilers and Water Heaters) *(November 7, 2007)*

The District evaluated the requirements contained within BAAQMD and found no requirements that were more stringent than those already in District. Requirements for units with a rating greater than 75,000 Btu/hr but less than 2,000,000 Btu/hr are included under District Rule 4308 and have at least as stringent or more stringent limits than those in SMAQMD Rule.

	SJVAPCD	BAAQMD
Applicability	Manufacturers, distributors, retailers, and installers of PUC quality natural gas-fired residential water heaters with heat input rates ≤ 75,000 Btu/hr	This rule limits the emissions of nitrogen oxides from natural gas-fired water heaters and boilers
Exemption	• 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 requirement *[No person shall sell, install, or offer for sale within the District any natural gas-fired storage tank water heater, manufactured after July 1, 1992, with a rated heat input capacity of 75,000 BTU/Hour or less, that emits more than 40 ng/J.]* 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: • mobile home water heater unless it is certified to a NOx emission level of ≤ 40 ng/J. • pool heater unless it is certified to a NOx emission level of ≤ 40 ng/J. • water heater, excluding mobile home water heaters, instantaneous water heaters, and pool heaters, unless it is certified to a NOx emission level of ≤ 10 ng/J. • instantaneous water heater unless it is certified to a NOx emission level of ≤ 14 ng/J.	Natural gas-fired storage tank water heaters with a rated heat input capacity ≤ 75,000 Btu/hr: • No person shall sell, install, or offer for sale within the District any natural gas-fired storage tank water heater that emits > 10 ng/J. This subsection shall not apply to water heaters used for mobile homes. Natural gas-fired boilers and water heaters with a rated heat input capacity of 75,001 to 2,000,000 Btu/hr: • No person shall sell, install, or offer for sale within the District any large natural gas-fired boiler, storage tank water heater, or instantaneous water heater with a rated heat input capacity from 75,001 to 400,000 Btu/hr, inclusive, manufactured after January 1, 2013, that emits more than 14 ng/J. • No person shall sell, install, or offer for sale within the District any large natural gas-fired boiler, storage tank water heater, or instantaneous water heater with a rated heat input capacity from 400,001 to 2,000,000 Btu/hr, inclusive, manufactured after January 1, 2013, that emits more than 14 ng/J, or more than 20 ppm NOx at 3% O2, dry. No person shall sell, install, or offer for sale within the District any natural gas-fired mobile home water heater that emits > 40 ng/J. No person shall sell, install, or offer for sale within the District any natural gas-fired pool/spa heater

		with an input rating from 400,001 to 2,000,000 Btu/hr that emits > 14 ng/J, or > 20 ppm NOx at 3% O2, dry.

VCAPCD

- VCAQPCD Rule 74.11 (Natural Gas-Fired Water Heaters)

The District evaluated the requirements contained within VCAQMD and found no requirements that were more stringent than those already in District Rule 4902. Requirements for units with a rating greater than 75,000 Btu/hr but less than 2,000,000 Btu/hr are included under District Rule 4308 and have at least as stringent or more stringent limits than those in SMAQMD Rule.

	SJVAPCD	VCACPD
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 selling, offering for sale, or installing natural gas-fired water heaters, including mobile home water heaters, rated at < 75,000 Btu/hr in Ventura County
Exemption	• 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 provisions of this rule shall not apply to: 1. Water heaters with a rated heat input ≥ 75,000 Btu/hr 2. Water heaters used in recreational vehicles
Requirements	• No person shall manufacture for sale, distribute, sell, offer for sale, or install within the District any PUC quality natural gas-fired: • mobile home water heater unless it is certified to a NOx emission level of ≤ 40 ng/J. • pool heater unless it is certified to a NOx emission level of ≤ 40 ng/J. • water heater, excluding mobile home water heaters, instantaneous water heaters, and pool heaters, unless it is certified to a NOx emission level of ≤ 10 ng/J. • instantaneous water heater unless it is certified to a NOx emission level of ≤ 14 ng/J.	• No person shall sell, offer for sale, or install within Ventura County any natural gas-fired water heater unless the water heater is certified to a NOx emission level ≤: ○ 10 ng/J; or ○ 15 ppmv at 3% O2, dry • No person shall sell, offer for sale, or install within Ventura County any natural gas-fired mobile home water heater unless the water heater is certified to a NOx emission level ≤: • 40 ng/J; or • 55 ppmv at 3% O2, dry

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

Beyond the review of current regulation and rule requirements, the District performed an extensive review of the feasibility of expanding applicability or removal of exemptions for this source category, technologies and measures that have been implemented in practice in other regions, and potential new technologies and measures that may be feasible for implementation in the near future. Based on this exhaustive review, District staff did not find any additional measures currently available or will be available prior to the 2025 attainment deadline date that could improve the effectivity of this rule.

As stated above, the most recent amendment of Rule 4902 strengthened the emission limit and as a result, NOx emissions have been controlled by approximately 88% for this source category. Units subject to Rule 4902 are fired on PUC quality natural gas, and are inherently low-emitters of SOx and PM2.5 emissions. Given the significant efforts and investments already made to reduce emissions from this source category, there are little remaining opportunities for obtaining additional emissions reductions. For the sake of thoroughness, the possibility of further reducing emissions from natural-gas fired water heaters is evaluated in the following discussion.

The potential opportunity evaluated is the possibility of achieving additional emission reductions from this category by taking advantage of lower emitting water heating technology. Rule 4902 is a point of sale rule, and nearly all water heaters sold in the District are conventional storage water heaters that operate on natural gas. The potential opportunity would be to replace natural gas and propane water heaters with units that run on electricity. A comparison of three water heaters that utilize the different fuel types with an emissions reduction and cost effectiveness analysis for these units is summarized below.

Emissions Reductions and Cost Effectiveness of Water Heaters by Fuel Type

Fuel Type	Low NOx Natural Gas	Propane	Electricity
Capacity[1]	50 gallons	50 gallons	50 gallons
Shipping Weight[1]	146 lbs	146 lbs	117 lbs
Energy Factor[1]	0.62	0.62	0.93
Purchase Price[1]	$895.00	$1,132.00	$650.00
Estimated Life Expectancy[2]	13 years	13 years	13 years
Lifetime Energy Use[2]	3,133 therms	2,867 gallons of LP	62,439 kWh
Lifetime Energy Costs[3]	$3,919	$6,852	$9,922
Lifetime NOx Emissions[4]	30.60 lbs	48.09 lbs	0.00 lbs
Annual NOx Emissions	2.35 lbs	3.70 lbs	0.00 lbs
Comparing Natural Gas and Propane to Electricity			N/A
Annualized capital cost[5]	$105.76	$105.76	
Annual Operating Cost Savings Compared to Electric	$461.71	$236.11	
Cost per pound NOx	$241.50	$92.40	
Cost per ton NOx	**$482,945**	**$184,792**	

[1] Unit specifications and prices acquired from Grainger Industrial Supply as of June 14, 2018
[2] Data from US Department of Energy – Energy Cost Calculator for Electric and Gas Water Heaters http://www1.eere.energy.gov/femp/technologies/eep_waterheaters_calc.html
[3] Cost data based on the of the average cost of units of energy in 2017 according to the US Energy Information Administration. http://www.eia.gov/
[4] Emissions factors derived from Appendix EA-1 of US Department of Energy's Energy Assessment for Proposed Energy Conservation Standards for Residential Clothes Washers
[5] The annualized capital equipment cost is calculated by multiplying the installed equipment cost by the capital recovery factor of 0.1627.

The operating cost for electric water heaters is higher than for propane and natural gas units, due to the higher cost of electricity over propane and natural gas. However, the initial purchase price is considerably lower for electric units. Converting to an electric water heater also may require modifications to the residence and have associated costs, though electric water heaters are amongst the safest units available. Electric units also weigh considerably less, due to the lack of safety equipment needed on a gas fueled water heater. While the lifetime cost of an electric water heater is higher than that of propane and natural gas, the emissions benefits may make converting to electric water heating a viable control strategy.

EVALUATION FINDINGS

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this source category. As demonstrated above, Rule 4902 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category. As the District continues to develop new attainment plans that address more stringent National Ambient Air Quality Standards, the District will continue to evaluate potential opportunities to reduce emissions from this source category in the Valley.

C.21 Rule 4905 (Natural Gas-Fired, Fan-Type Central Furnaces)

Discussion

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. The rule NOx emission limit was set at 0.093 pounds per million Btu of heat output (lb/MMBtu). January 2015 amendments lowered the NOx emission limit for residential units from 40 ng/J (0.093 lb/MMBtu) to 14 ng/J, 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. EPA approved these amendments into the SIP effective April 28, 2016.[84] Due to the limited number of certified compliant units that will be available by the compliance deadline dates, the rule was amended again on June 21, 2018 to extend the implementation period for another 12 months to allow an additional period of time necessary to continue technology development and the certification process while providing strong incentive for accelerated deployment of compliant units.

Emissions Inventory

Pollutant	2013	2016	2019	2020	2021	2023	2024	2025	2026
	Annual Average - Tons per day								
PM2.5	0.20	0.21	0.21	0.21	0.22	0.22	0.22	0.22	0.22
NOx	2.44	2.54	2.43	2.38	2.33	2.24	2.18	2.13	2.07
	Winter Average - Tons per day								
PM2.5	0.26	0.27	0.28	0.28	0.29	0.29	0.29	0.29	0.30
NOx	3.25	3.38	3.23	3.16	3.10	2.98	2.90	2.83	2.75

Source Category

This source category includes natural gas-fired central furnaces in the Valley that have a rated heat input capacity of less than 175,000 British thermal units per hour (Btu/hr), and combination heating and cooling units with a rated cooling capacity of less than 65 Btu/hr. All heating systems have three basic components: a heat source, a heat distribution system, and a control system. The control system is usually a programmable thermostat. The heat source, which generally determines the type of distribution system used, is selected based on many factors. The most important factor is geographical location, which determines the climate and types of available fuel. Most commercial and residential buildings in the Valley have access to natural gas, which is typically the cheapest and most convenient fuel source in areas where it is available. Furnaces fueled by natural gas use forced air distribution, the most common type of heating system for residential and commercial buildings. Central furnaces are

[84] Approval of California Air Plan Revisions, San Joaquin Valley Unified Air Pollution Control District and South Coast Air Quality Management District. Final Rule. 81 Fed. Reg. 17390. (2016, March 29). (to be codified at 40 CFR Part 52). https://www.gpo.gov/fdsys/pkg/FR-2016-03-29/pdf/2016-06962.pdf

controlled by a thermostat, which sends signals to turn the device 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 combust the gas directly into the heat exchangers. A blower pulls air from outside the building through a filter, across the heat exchanger, and through 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 utilize 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 and, pre-heat the air typically to 50-60°F, using 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.[85]

HOW DOES DISTRICT RULE 4905 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

The District identified federal, state, and local air quality regulations and compared them to analogous District rules to identify potential emission reductions opportunities. Any potential opportunities identified were then analyzed to determine if they are technologically and economically feasible to require in Valley.

Federal Regulations

There are no EPA CTG, ACT, NSPS, NESHAP, or MACT requirements for 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?

There are no analogous rules for this source category in SMAQMD.

SCAQMD

- SCAQMD Rule 1111 (Reduction of NOx Emissions from Natural) *(Amended July 6, 2018)*

As summarized above, the District evaluated the requirements contained within SCAQMD Rule 1111 and found no requirements that were more stringent than those already in Rule 4905.

[85] U.S. Department of Energy. (2014, July 7). *Energy Conservation Program for Consumer Products: Energy Conservation Standards for Residential Furnace Fans.* Retrieved 9/23/14 from https://www.federalregister.gov/articles/2014/07/03/2014-15387/energy-conservation-program-for-consumer-products-energy-conservation-standards-for-residential.

	SJVAPCD	SCAQMD
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
Exemption	• 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 October 1, 2012 • Natural gas furnace installed with propane conversion kit for propane firing only
Requirements	Furnaces must not exceed NOx limit of 14 ng/J	Furnaces must not exceed NOx limit of 14 ng/J

BAAQMD

- BAAQMD Regulation 9 Rule 4 (Nitrogen Oxides from Fan Type Residential Central Furnaces) *(Amended December 7, 1983)*

The District evaluated the requirements contained within BAAQMD Regulation 9 Rule 4 and found no requirements that were more stringent than those already in Rule 4905.

	SJVAPCD	BAAQMD
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 central furnaces with rated heat input capacity of < 175,000 btu/hr, excluding heating/cooling units utilizing three phase electric current
Exemption	• Natural gas furnace not exceeding NOx emissions of 40 ng/J and installed with propane conversion kit for propane firing only	Although BAAQMD does not explicitly provide any exemptions, the rule only applies to residential furnaces and excludes heating/cooling units
Requirements	Furnaces must not exceed NOx limit of 14 ng/J	Furnaces must not exceed NOx limit of 40 ng/J

VCAPCD

- VCAQPCD Rule 74.22 (Natural Gas-Fired, Fan-Type Central Furnaces) *(Adopted November 9, 1993)*
-

The District evaluated the requirements contained within VCAPCD Rule 74.22 and found no requirements that were more stringent than those already in Rule 4905.

	SJVAPCD	VCAPCD
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
Exemption	• Natural gas furnace not exceeding NOx emissions of 40 ng/J and installed with propane conversion kit for propane firing only	Units installed in manufactured housing
Requirements	Furnaces must not exceed NOx limit of 14 ng/J	Furnaces must not exceed NOx limit of 40 ng/J

SCAPCD

- SDAPCD Rule 69.6 (Natural Gas-Fired Fan Type Central Furnaces) *(Adopted June 17, 1998)*

The District evaluated the requirements contained within San Diego APCD Rule 69.6 and found no requirements that were more stringent than those already in Rule 4905.

	SJVAPCD	San Diego APCD
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	Furnaces with rated heat input capacity of < 175,000 btu/hr or < 65,000 btu/hr for combination heating and cooling units
Exemption	• Natural gas furnace not exceeding NOx emissions of 40 ng/J and installed with propane conversion kit for propane firing only	Units installed in mobile homes
Requirements	Furnaces must not exceed NOx limit of 14 ng/J	Furnaces must not exceed NOx limit of 40 ng/J

Additional Emission Reduction Opportunities

This rule implements requirements that go beyond most stringent measures feasible to implement in the Valley, as evidenced by the need for the District to amend this rule this year to extend the deadlines to provide manufacturers additional time to research, develop, certify, and commercialize compliant units. As such, there are no additional emission reductions opportunities identified at this time.

Evaluation Findings

The District has evaluated all potential control technologies and all control technologies achieved in practice in other areas or included in other state implementation plans for this source category. As demonstrated above, Rule 4905 currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category. As the District continues to develop new attainment plans that address more stringent National Ambient Air Quality Standards, the District will continue to evaluate potential opportunities to reduce emissions from this source category in the Valley.

C.22 Regulation VIII (Fugitive PM10 Prohibitions)

Discussion

The District's Regulation VIII series (Fugitive PM10 Prohibitions) was adopted in November 2001, and subsequently amended in 2004. This series contain a comprehensive suite of rules to reduce fugitive PM10 emissions from a range of sources as described below:

Rule 8011: General Requirements
The provisions of Rule 8011 are applicable to specified outdoor fugitive dust sources. The definitions, exemptions, requirements, administrative requirements, recordkeeping requirements, and test methods set forth in this rule are applicable to all rules under District Regulation VIII (Fugitive PM10 Prohibitions). 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 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 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; thresholds for any site with 150 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. In 2004, Rule 8041 was amended to require a threshold for vehicles with three or more axles to takes actions for carryout/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/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 visible dust emissions (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. In 2004, Rule 8051 was amended 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 also establishes thresholds that when exceeded require that roads are treated to reduce visible dust emissions. In 2004, Rule 8061 was amended to replace the existing 75 maximum daily vehicle trip threshold with a 26 annual average daily vehicle trips (AADT) threshold on unpaved roads, and require all new unpaved roads within urban areas be paved.

Rule 8071: Unpaved Vehicle/Equipment Traffic Areas
Rule 8071 is applicable to unpaved vehicle/equipment areas, parking, fueling and service areas, and shipping, receiving, and transfer areas. The rule contains requirements for when vehicle traffic reaches or exceeds specified thresholds, limitations on visible dust emissions (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. In 2004, Rule 8071 was amended to remove the 1.0 acre or larger threshold; change the vehicle threshold from 75 vehicle daily trips to 50 annual average daily trips; 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 whenever 25 or more three-axle vehicle trips will 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/equipment traffic areas, and bulk materials. The rule contains requirements to limit visible dust emissions (VDE) and/or to comply 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. In 2004, Rule 8081 was amended to add an exemption to the rule for vehicle/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 vehicle daily trips 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/equipment traffic area.

EMISSIONS INVENTORY

Rule 8021: Construction, Demolition, Excavation, Extraction, and Other Earthmoving Activities

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026
	Annual Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	1.52	1.70	1.85	1.89	1.54	1.56	1.58	1.61	1.64	1.67
	Winter Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	1.39	1.55	1.70	1.73	1.41	1.43	1.45	1.48	1.50	1.53

Rule 8031: Bulk Materials

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026
	Annual Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06
	Winter Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	0.04	0.05	0.05	0.05	0.05	0.06	0.06	0.06	0.06	0.06

Rule 8041: Carryout and Trackout

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026

	Annual Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	3.26	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82	2.82
	Winter Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	6.35	5.49	5.49	5.49	5.49	5.49	5.49	5.49	5.49	5.49

Rule 8051: Open Areas

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026
	Annual Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34	0.34
	Winter Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21

Rule 8061: Paved and Unpaved Roads

The emissions from this source category are included in Rule 8061 (Paved and Unpaved Roads).

Rule 8071: Unpaved Vehicle/Equipment Traffic Areas

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026
	Annual Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
	Winter Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52	0.52

Rule 8081: Agricultural Sources

Pollutant	2013	2016	2019	2020	2021	2022	2023	2024	2025	2026
	Annual Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0
PM2.5	1.20	1.18	1.17	1.17	1.16	1.16	1.15	1.15	1.14	1.14
	Winter Average - Tons per day									
NOX	0	0	0	0	0	0	0	0	0	0

PM2.5	1.47	1.45	1.43	1.43	1.42	1.42	1.41	1.41	1.40	1.39

HOW DOES DISTRICT REGULATION VIII COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations
There are no EPA CTG, ACT, NSPS, NESHAP, or MACT guidelines for 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.

- EPA-450/2-92-004 (Fugitive Dust Background Document and Technical Information Document for Best Available Control Measures (BACM))

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?

There are no analogous rules for this source category in BAAQMD.

SCAQMD
- Rule 1156 (Further Reductions of Particulate Emissions from Cement Manufacturing Facilities) (Amended November 6, 2015)

The District evaluated the requirements contained within SCAQMD Rule 1156 and found no requirements that were more stringent than those already in Regulation VIII.

- Rule 1157 (PM10 Emission Reductions form Aggregate and Related Operations) (Amended September 8, 2008)

The District evaluated the requirements contained within SCAQMD 1157 and found no requirements that were more stringent than those already in Regulation VIII.

SMAQMD
- Rule 403 (Fugitive Dust) (Amended August 3, 1977)

The District evaluated the requirements contained within SMAQMD Rule 403 and found no requirements that were more stringent than those already in Regulation VIII.

VCAPCD

- Rule 55 (Fugitive Dust) (Adopted June 10, 2008)

The District evaluated the requirements contained within VCAPCD Rule 55 and found no requirements that were more stringent than those already in Regulation VIII.

Clark County Department of Air Quality (CCDAQ)

- Section 41 (Fugitive Dust) (Adopted April 15, 2014)

The District evaluated the requirements contained within CCDAQ Section 41 and found no requirements that were more stringent than those already in Regulation VIII.

- Section 91 (Fugitive Dust from Unpaved Roads, Unpaved Alleys, and Unpaved Easement Roads) (Amended April 15, 2014)

The District evaluated the requirements contained within CCDAQ Section 91 and found no requirements that were more stringent than those already in Regulation VIII.

- Section 92 (Fugitive Dust from Unpaved Parking Lots and Storage Areas) (Amended April 15, 2014)

The District evaluated the requirements contained within CCDAQ Section 92 and found no requirements that were more stringent than those already in Regulation VIII.

- Section 93 (Fugitive Dust from Paved Roads and Street Sweeping Equipment) (Amended April 15, 2014)

The District evaluated the requirements contained within CCDAQ Section 93 and found no requirements that were more stringent than those already in Regulation VIII.

- Section 94 (Permitting and Dust Control for Construction Activities) (Amended July 1, 2004)

The District evaluated the requirements contained within CCDAQ Section 94 and found no requirements that were more stringent than those already in Regulation VIII.

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 no requirements that were more stringent than those already in Regulation VIII.

Additional Emission Reduction Opportunities

Regulation VIII currently employs the best dust mitigation techniques. There are no additional potential opportunities for further emissions reductions from this source category.

Furthermore, while District Regulation VIII was critical in the District's attainment of the PM10 standards, a variety of studies have been conducted which may 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. In addition, studies have shown that geologic dust alone has relatively low toxicity.

Evaluation Findings

The District has evaluated all potential requirements achieved in practice in other areas or included in other state implementation plans. As demonstrated above, Regulation VIII currently has in place the most stringent measures feasible to implement in the Valley and therefore meets or exceeds RACM, BACM, and MSM requirements for this source category.

C.23 RULE 9510 (INDIRECT SOURCE REVIEW)

DISCUSSION

Rule 9510 Indirect Source Review (ISR) was adopted in December 15, 2005 and amended in December 2017 and is the only rule of its kind in the State of California and throughout the nation. The District's rule is recognized as the benchmark, or best available control, for regulating these indirect sources of emissions. State and federal laws are prescriptive in establishing the District's authority regulating indirect sources. These complex legal requirements were well documented and litigated as the District spent over five years successfully defending its existing rule through the highest courts at the state and federal levels. The emission control requirements under the District's current rule are as stringent as possible in adherence with all applicable state and federal regulations and case law.

The California Air Resources Board, South Coast Air Quality Management District, Bay Area Air Quality Management District and other air districts are currently attempting to replicate the success of the rule in the development of their own Indirect Source Review rules by utilizing San Joaquin Valley Air District's experience and regulatory language to help guide their efforts.

The rule is to reduce the growth in NOx and PM emissions from mobile and area sources associated with construction and operation of new development projects in the Valley. The ISR rule applies to developers of new residential, commercial and industrial projects and to transportation and transit projects whose emissions will exceed certain thresholds contained in the rule. The ISR rule encourages clean air designs to be incorporated into the development project, or, if insufficient emissions reductions can be designed into the project, by paying a mitigation fee that will be used to fund off-site emissions reduction projects. A significant improvement has occurred in the design of development projects in the Valley through the incorporation of features that result in reduced emissions. Since adoption of the rule, developers have voluntarily begun to incorporate many air-friendly design changes into their projects. For instance, significant reductions in emissions have occurred through the use of a "construction clean fleet", which is defined as a construction fleet mix cleaner than the State fleet average. Another noteworthy change is that developers of large distribution centers are continuing to reduce operational emissions and associated impacts through voluntarily committing to use newer heavy-duty on-road fleet vehicles and maintaining a fleet replacement schedule that ensures older vehicles are replaced in a timely manner. In 2006, the first year of implementation, only 14.3% of approved projects reduced construction exhaust impacts through use of a clean construction equipment fleet. The percentage has risen to approximately 33% for the entire history of the ISR program, and 46% for the reporting period of 2017.

The population in the San Joaquin Valley is expected to be one of the fastest growing regions in the state through at least 2033. The Demographic Research Unit of the Department of Finance released interim revised population growth projections in January 2018 and expects approximately 21.8% growth in the Valley's population during the 2018 to 2033 period. In contrast, the total population for the State of

California is projected to increase by only 12.7% over the same period.86 As land development and population in the San Joaquin Valley continue to increase, area source emissions from activities such as consumer product use, fuel combustion for heating and cooking, and landscape maintenance will increase. The total number of vehicle miles traveled (VMT) also increases with population growth, resulting in more emissions due to the combustion of vehicle fuels.

The projected growth in these so called “indirect source” emissions erodes some of the progress generated by emission reductions achieved through the District’s stationary source program and state and federal mobile source controls. The emissions are called indirect because they do not come directly from a smokestack, like traditional industry emissions, but rather the emissions are indirectly caused by this growth in population.

Mobile source emissions make up over 85% of the Valley’s primary driver in the formation of particulate matter (PM) and ozone pollution, and therefore reductions in mobile source emissions have become an ever-increasingly important part of the District’s clean air strategies. Although the San Joaquin Valley Air Pollution Control District (District) has no regulatory authority to control tailpipe emissions from motor vehicles, the District undertook groundbreaking action to reduce vehicle miles traveled by adopting Rule 9510 Indirect Source Review (ISR).

Emissions Inventory

There is no emission inventory specific to Rule 9510.

Source Category

The ISR rule applies to developers of new residential, commercial and industrial projects and to transportation and transit projects whose emissions will exceed certain applicability thresholds contained in the rule. The rule requires a development project construction to reduce NOx emissions by 20% and reduce a development project’s operational NOx emissions by 33.3% and 50%, when compared to unmitigated project baseline emissions. NOx emissions can come from the combustion of fuels in motor vehicles, and other off-road vehicles such as construction equipment. PM emissions can be from fugitive dust particles or fine particles directly emitted from combustion processes.

A development project is subject to the ISR rule if it received its final discretionary approval from a public agency on or after March 1, 2006, and meets or exceeds any one of the following District applicability thresholds:

2,000 sq. ft commercial	25,000 sq. ft. light industrial	100,000 sq. ft. heavy industrial
20,000 sq. ft. medical office	39,000 sq. ft general office	9,000 sq. ft. educational
10,000 sq. ft. government	20,000 sq. ft. recreational	50 residential units
9,000 sq. ft. of space not included in the list		

[86] State Population Projections (2010-2060). Total Population by County (1-year increments). (2018, January) *Retrieved from*: http://www.dof.ca.gov/Forecasting/Demographics/Projections/

A development project meeting or exceeding any one of the following District "Large Development Project" applicability thresholds is subject to ISR if it received its project-level approval from a public agency on or after March 21, 2018:

10,000 sq. ft commercial	125,000 sq. ft. light industrial	500,000 sq. ft. heavy industrial
100,000 sq. ft. medical office	195,000 sq. ft general office	45,000 sq. ft. educational
50,000 sq. ft. government	100,000 sq. ft. recreational	250 residential units
45,000 sq. ft. of space not included in the list		

Developers of projects subject to Rule 9510 must reduce emissions occurring during construction and operational phases through on-site emission reduction measures, or by paying off-site mitigation fees. One hundred percent of all off-site mitigation fees are used by the District to fund emission reduction projects through its Emission Reduction Incentive Programs, achieving emission reductions on behalf of the project. The use of clean air project design elements that reduce the vehicle miles travelled associated with a project, operational measures such as the use of clean trucking fleets, and construction measures such as the use of clean construction fleets have resulted in 12,500 tons of NOx and PM10 reductions over the life of the program. In addition, project proponents that have found the payment of offsite mitigation fees to be a more feasible and cost effective manner to meet the requirements of Rule 9510 have generated another 6,900 tons of NOx and PM10 reductions through the investment of those mitigation fees in local emissions reduction projects utilizing the District's incentive grant programs.

HOW DOES DISTRICT RULE 9510 COMPARE WITH FEDERAL AND STATE RULES AND REGULATIONS?

Federal Regulations

Federal requirements such as NSPS, NESHAP, MACT, CTGs, and ACTs and state regulations are not applicable to this source category.

State Regulations

There are no state regulations applicable to this source category.

HOW DOES DISTRICT RULE 9510 COMPARE TO RULES IN OTHER AIR DISTRICTS?

The requirements and applicability of Rule 9510 were compared to analogous rules in other air districts and states to determine the stringency of Rule 9510 compared to those other rules. The District has not identified any agencies with indirect source regulations analogous to Rule 9510.

ADDITIONAL EMISSION REDUCTION OPPORTUNITIES

The District is the only air quality agency in the nation that has established a regulatory framework for reducing indirect mobile source-related emissions from development.

EVALUATION FINDINGS

The ISR rule have been successfully reducing the growth in NOx and PM10 emissions associated with the construction and operation of new development projects, including transportation and transit development projects in the San Joaquin Valley since the inception of the rule. The District publishes annual reports on the District's ISR program, which provides documentation that the ISR rule and VERA are effective in reducing emissions associated with the construction and operation of new development projects in the Valley.

C.24 Ammonia in the San Joaquin Valley

Extensive scientific research and technical analyses demonstrate that ammonia reductions do not contribute to the Valley's PM2.5 attainment (see Appendix G) and, therefore, does not need to be addressed as a part of the District's review of BACM and MSM. Even though ammonia is an insignificant PM2.5 precursor in the Valley, the following analysis shows that the Valley's ammonia emissions have been significantly reduced through stringent regulations, that additional ammonia control measures are infeasible, and that Valley sources are already implementing BACM and MSM.

As demonstrated in Appendix B of this Plan, the three main sources of ammonia emissions in the Valley from stationary and area sources that account for 95% of the Valley's ammonia emissions are as follows (based on CEPAM v1.05 Annual Average Emissions Inventory for 2018):

- Farming Operations with 186.5 tons per day (tpd), and
- Solvent evaporation from Agricultural Fertilizers at 114.4 tpd, and
- Composting Solid Waste Operations at 6.2 tpd.

The following discussion evaluates:

- Confined Animal Facilities (District Rule 4570)
- Agricultural Fertilizers
- Biosolids, Animal Manure, and Poultry Litter Operations (District Rule 4565)
- Organic Material Composting (District Rule 4566)
- Major Sources of Ammonia

RULE 4750 (CONFINED ANIMAL FACILITIES)

Discussion

District Rule 4570, was originally adopted on June 15, 2006 and was most recently amended on October 21, 2010. The purpose of this rule is to limit emissions of volatile organic compounds (VOC) from Confined Animal Facilities (CAF). 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 VOC emissions, District Rule 4570 also includes measures that control ammonia (NH3) emissions from these operations; the required measures have reduced ammonia emissions by over 100 tpd[87].

Source Category

Confined Animal Facilities are used for the raising of animals including, but not limited to, cattle, calves, chickens, ducks, goats, horses, sheep, swine, rabbits, and turkeys, which are corralled, penned, or otherwise caused to remain in restricted areas for

[87] Appendix F of the Staff Report for the June 2009 re-adoption of Rule 4570, starting on the 329th page of the pdf available here http://www.valleyair.org/Board_meetings/GB/agenda_minutes/Agenda/2009/June/Agenda%20Item_10_June_18_200.pdf

commercial agricultural purposes and fed by a means other than grazing. (CH&SC §39011.5 (a)(1)). The major categories of Confined Animal Facilities are listed below.

- Dairy Operations - Dairy operations are those operations producing milk or animals for facilities that produce milk.
- Poultry Operations - Poultry facilities operate either as layer ranches for egg production or as broiler ranches where birds are grown for the fresh meat market.
- Beef Cattle Feeding Operations – Beef cattle facilities are facilities that raise beef cattle (heifers and steers) for their meat.
- Swine Operations – These operations raise pigs for their meat. The production cycle for hogs has three (3) phases: farrowing (giving birth), nursing, and finishing.

Rule 4570 Applicability Thresholds

The thresholds for a facility to be classified as a large CAF in the Valley and the thresholds for a facility to be subject to District Rule 4570 are shown in the following table. The large CAF thresholds are based on the definition of a large CAF adopted by ARB as required by California Senate Bill (SB) 700. District Rule 4570 applies to confined animal facilities that have the capacity to house a number of animals equal to or exceeding the Rule 4570 regulatory thresholds, which are lower than the large CAF thresholds for certain facilities.

Rule 4570 Applicability for Regulation		
Livestock Category	**SJVAPCD Large CAF Thresholds**	**Rule 4570 Regulatory Thresholds**
Dairy	1,000 milking cows	500 milking cows
Beef Feedlots	3,500 beef cattle	3,500 beef cattle
Other Cattle Facility	7,500 calves, heifers, or other cattle	7,500 calves, heifers, or other cattle
Poultry Facilities		
Chicken	650,000 head	400,000 head
Duck	650,000 head	400,000 head
Turkey	100,000 head	100,000 head
Swine Facility	3,000 head	3,000 head
Horses Facility	3,000 head	3,000 head
Sheep and Goat Facilities	15,000 head of sheep, goats, or any combination of the two	15,000 head of sheep, goats, or any combination of the two
Any livestock facility not listed above	30,000 head	30,000 head

Emission Control Requirements of District Rule 4570

District Rule 4570 requires multiple mitigation measures from the following CAF categories: Dairy, Beef Feedlots, Other Cattle Facilities, Swine Facilities, Poultry facilities, and various other smaller operations. Each of these facilities consists of multiple sources of emissions within the facility. 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. Mitigation measures required by Rule 4570 have been tailored for each source of emissions, thereby ensuring that the overall emissions from a facility are reduced. The current methodology in Rule 4570 allows for the greatest overall control from the entire facility.

District Rule 4570 recognized the following five emission sources for all of the CAFs: Feed, Housing, Solid Waste, Liquid Waste, and Land Application of Manure. Rule 4570 requires each CAF to implement a certain number of mitigation measures for each of these sources. District Rule 4570 also distinguishes between the different types of housing configurations (freestall vs open corrals) for cattle and, as such, requires specific mitigation measures for each type of housing. By requiring mitigation measure(s) for each source of emissions at a facility, District Rule 4570 ensures that reductions are achieved throughout the facility.

Ammonia is produced on livestock operations when urea (present in urine) is broken down by the enzyme urease (present in feces and soil) to form ammonia gas and carbamine acid, which further decomposes to release another molecule of ammonia gas and carbon dioxide. When urine mixes with feces or soil, ammonia is volatilized (lost to the air) within minutes, but the reaction may continue for several hours depending on a variety of factors, taking anywhere from a few hours to days to reach peak levels. The rate is dependent on the amount of urea and urease available for reaction, as well as meteorological conditions such as temperature and wind speed. Production of ammonia is an inevitable part of livestock production, but ammonia emissions can be reduced through management practices, such as those required by District Rule 4550, that help to prevent ammonia formation and volatilization.

The following describes some of the mitigation measures required by District Rule 4570, and the ways in which these measures reduce ammonia emissions:

- Nutritional management: Ammonia emissions result from the decomposition of undigested nitrogen compounds in animal waste. Proper nutritional management, with diets formulated to feed proper amounts of protein, improves nitrogen utilization by the animal, reducing production of ammonia from animal waste.[88]

- Increased cleaning and removal of manure and litter from animal housing areas: Because animal waste is the primary source of ammonia emissions at confined animal facilities, increased removal of waste from animal housing areas will reduce ammonia emissions. Proper management of the waste will stabilize the nitrogen compounds, which will reduce the rate that these compounds are converted to ammonia that can be lost to the atmosphere. In addition, ammonia is highly soluble in water; therefore, when a flush system is used, ammonia emissions will be reduced because much of the ammonia will dissolve in the water rather than volatilize to the air.

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[88] 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.

Research by Schmidt, Card, Gaffney, and Hoyt (2005) indicated significantly lower NH3 emissions after cleaning of the lanes at a dairy. Research by Beene, Krauter, and Goorahoo (2005) also indicated lower NH3 emissions after cleaning of the lanes at the dairies monitored[89]. Other research by Card and Schmidt supports that management of manure in corrals reduces NH3 emissions from the corrals and points out that of the two dairies tested, the NH3 emissions from the dairy with constantly managed corrals (Dairy 2) had "exceptionally low ammonia emissions".[90]

- Incorporation of manure into fields: Incorporation of manure in fields reduces volatilization of gaseous pollutants by minimizing the amount of time that the manure is exposed to the atmosphere. Once the waste has been incorporated into the soil, VOCs and ammonia are absorbed onto soil particles, providing the opportunity for these soil microbes to oxidize these compounds into carbon dioxide, water, and nitrates.

NH3 emissions from confined animal facilities result from the microbial decomposition of nitrogenous compounds in manure and the subsequent volatilization of the ammonia that is produced. The study "Emissions of Volatile Organic Compounds Originating from UK Livestock Agriculture" (2004) by Hobbs, Webb, Mottram, Grant, and Misselbrook determined that, "there is a close association between ammonia and NMVOC (non-methane volatile organic compound) productions from manure" and "NMVOC emissions remain in a relatively constant ratio to those of ammonia". [91] Other researchers have also found similar relationships between NMVOC and NH3. For example, a correlation between NH3 and several individual NMVOCs was found in a study by Feilberg, Liu, Adamsen, Hansen, and Jonassen (2010).[92] This is expected because many of the VOCs emitted from confined animal facilities, including dairies, also originate from the decomposition of undigested protein in manure. Therefore, the measures included in District Rule 4570 to reduce VOC emissions from manure are also expected to reduce NH3 emissions.

Research has demonstrated that silage and silage-based total mixed ration (TMR) are one of the largest sources of VOC emissions at cattle facilities, but are not significant

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[89] Schmidt, C.E., Card, T., Gaffney, P., and Hoyt., S. (2005) California Air Resource Board (ARB) and Central California Ozone Study (CCOS) Project: Assessment of Reactive Organic Gases and Amines from a Northern California Dairy Using the USEPA Surface Emissions Isolation Flux Chamber. 14th USEPA Annual Emissions Inventory Conference Las Vegas, Nevada, April, 2005. Technical Paper. Available at: http://www.epa.gov/ttn/chief/conference/ei14/session1/schmidt.pdf

[90] Card, T. and Schmidt, C. (2006) Dairy Air Emissions Report: Summary of Dairy Emission Estimation Procedures (May 2006). Final Report to California Air Resource Board (ARB).
http://www.arb.ca.gov/ag/caf/SchmidtDairyEmissions2005.pdf
http://www.arb.ca.gov/ag/caf/SchmidtDairyTestData2005.pdf

[91] Hobbs, P.J. Webb, J. Mottram, T.T. Grant, B. Misselbrook, T.M. (2004) Emissions of Volatile Organic Compounds Originating from UK Livestock Agriculture. 2004©. Society of Chemical Industry. J Sci Food Agric 84:1414-1420 http://www.valleyair.org/busind/pto/dpag/VOC_from_UK_livestock.pdf

[92] Feilberg, A, Liu, D., Adamsen, A.P.S., Hansen M.J., Jonassen K.E.N. (2010). Odorant Emissions from Intensive Pig Production Measured by Online Proton-Transfer-Reaction Mass Spectrometry. Environmental Science & Technology Vol.44:5894–900.

sources of NH3 emissions. Therefore, the measures that specifically apply to management of silage and TMR will not be discussed in detail in this analysis.

It should be noted that, although Rule 4570 includes some options to provide flexibility to the operators of CAFs and that the majority of these measures are expected to reduce NH3 emissions, it also specifically requires certain measures that reduce NH3 emissions. Examples of mitigation measures specifically required in Rule 4570 that reduce NH3 emissions include the mitigation measures required at dairies and other cattle facilities for the areas in which the cattle are housed (e.g. barns, exercise pens, and corrals), such as increased cleaning and manure removal from lanes in freestall barns, corrals, and pens, and increased cleaning and manure removal from corrals and pen housing areas. These required measures have been shown to reduce NH3 emissions from these areas. Research has shown that for dairies and other cattle facilities the vast amount of NH3 emissions are from the areas in which the cattle are housed.[93, 94] Based on the current District NH3 emission factors,[95] the areas that house cattle are responsible for more than 72% of the NH3 emissions from dairies and other cattle facilities. Rule 4570 mitigation measures that are specifically required for the areas in which the cattle are housed include the following:

Rule 4570 Dairy CAF Phase II Mitigation Measures (Required)

Freestall Barns

1. Pave feedlanes, where present, for a width of at least eight (8) feet along the corral side of the feedlane fence for milk and dry cows and at least six (6) feet along the corral side of the feedlane for heifers.
2. a) Flush, scrape, or vacuum freestall flush lanes immediately prior to, immediately after, or during each milking; or b) Flush or scrape freestall flush lanes at least three (3) times per day.

Corrals/Pens

1. 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.
2. a) Clean manure from corrals at least four (4) times per year with at least sixty (60) days between cleaning; or b) Clean corrals at least once between April and July and at least once between September and December.
3. a) Scrape, vacuum, or flush concrete lanes in corrals at least once every day for mature cows and every seven (7) days for support stock; or b). Clean concrete lanes such that the depth of manure does not exceed twelve (12) inches at any point or time.

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[93] Schmidt, C. Card, T., and Gaffney, P. (2005). Assessment of Reactive Organic Gases and Amines from a Northern California Dairy Using the USEPA Surface Emission Isolation Flux Chamber. Presented at the Livestock Emissions Research Symposium held on January 26, 2005 at the San Joaquin Valley Air Pollution Control District, Fresno. https://www.arb.ca.gov/ag/agadvisory/schmidt05jan26.pdf
[94] Card, T. and Schmidt, C. (2006) Dairy Air Emissions Report: Summary of Dairy Emission Estimation Procedures (May 2006). Final Report to California Air Resource Board (ARB).
[95] SJVAPCD. (2018). Dairy Emission Factors. Retrieved from: https://www.valleyair.org/busind/pto/dpag/Dairy%20emission%20Factors.pdf

4. Inspect water pipes and troughs and repair leaks at least once every seven (7) days.
5. a) Slope the surface of the corrals at least 3% where the available space for each animal is 400 square feet or less. Slope the surface of the corrals at least 1.5% where the available space for each animal is more than 400 square feet per animal; or b) Maintain corrals to ensure proper drainage preventing water from standing more than forty-eight (48) hours; or c) Harrow, rake, or scrape corrals sufficiently to maintain a dry surface.
6. If the Confined Animal Facility (CAF) has shade structures, they must choose one of the following: a) Install shade structures such that they are constructed with a light permeable roofing material; or b) Install all shade structures uphill of any slope in the corral; or c) Clean manure from under corral shades at least once every fourteen (14) days, when weather permits access into the corral; or d) Install shade structure so that the structure has a North/South orientation.

Rule 4570 Beef Feedlot Phase II Mitigation Measures (Required)

Housing

1. Scrape corrals twice a year with at least ninety (90) days between cleanings, excluding the removal of in-corral mounds.
2. Inspect water pipes and troughs and repair leaks at least once every seven (7) days.
3. a) Slope the surface of the corrals at least 3% where the available space for each animal is 400 square feet or less. Slope the surface of the corrals at least 1.5% where the available space for each animal is more than 400 square feet per animal; or b) Maintain corrals to ensure proper drainage preventing water from standing more than forty-eight (48) hours; or c) Harrow, rake, or scrape corrals sufficiently to maintain a dry surface.
4. If the Confined Animal Facility (CAF) has shade structures, they must choose one of the following: a) Install shade structures such that they are constructed with a light permeable roofing material; or b) Install all shade structures uphill of any slope in the corral; or c) Clean manure from under corral shades at least once every fourteen (14) days, when weather permits access into the corral; or d) Install shade structure so that the structure has a North/South orientation.

Rule 4570 Other Cattle Phase II Mitigation Measures (Required)

Freestall Barns

1. Vacuum, scrape, or flush freestalls at least once every seven (7) days.
2. Pave feedlanes, where present, for a width of at least six (6) feet along the corral side of the feedlane.

Corrals/Pens

1. Scrape corrals twice a year with at least 90 days between cleanings, excluding in-corral mounds.

2. a) Scrape, vacuum, or flush concrete lanes in corrals at least once every seven (7) days; or b) Clean concrete lanes such that the depth of manure does not exceed twelve (12) inches at any point or time.
3. Inspect water pipes and troughs and repair leaks at least once every seven (7) days.
4. a) Slope the surface of the corrals at least 3% where the available space for each animal is 400 square feet or less. Slope the surface of the corrals at least 1.5% where the available space for each animal is more than 400 square feet per animal; or b) Maintain corrals to ensure proper drainage preventing water from standing more than forty-eight (48) hours; or c) Harrow, rake, or scrape corrals sufficiently to maintain a dry surface.
5. If the Confined Animal Facility (CAF) has shade structures, they must choose one of the following: a) Install shade structures such that they are constructed with a light permeable roofing material; or b) Install all shade structures uphill of any slope in the corral; or c) Clean manure from under corral shades at least once every fourteen (14) days, when weather permits access into the corral; or d) Install shade structure so that the structure has a North/South orientation.

In addition to these measures, which are specifically required for cattle CAFs by Rule 4570, CAFs must also choose to implement additional measures of Rule 4570 that are also expected to reduce NH3 emissions.

Estimated NH3 Reductions from Rule 4570 for Cattle Facilities

The NH3 reductions from cattle facilities as a result of the measures required below are conservatively estimated below based on the information that is currently available.

Increased cleaning of freestall lanes:

Research by Schmidt, Card, Gaffney, and Hoyt (2005) indicated significantly lower NH3 emissions after cleaning of the lanes at a dairy.[96] Research by Beene, Krauter, and Goorahoo (2005)[97] also indicated lower NH3 emissions after cleaning of the lanes at the dairies they monitored. Emission models have also indicated that increased cleaning of barns will reduce NH3 emissions. Research by Mendes, Pieters, Snoek and others (2017) using a process-based model indicated that scraping manure or scraping

[96] Schmidt, C.E., Card, T., Gaffney, P., and Hoyt., S. (2005) California Air Resource Board (ARB) and Central California Ozone Study (CCOS) Project: Assessment of Reactive Organic Gases and Amines from a Northern California Dairy Using the USEPA Surface Emissions Isolation Flux Chamber. 14th USEPA Annual Emissions Inventory Conference Las Vegas, Nevada, April, 2005. Technical Paper. Available at: http://www.epa.gov/ttn/chief/conference/ei14/session1/schmidt.pdf

[97] Beene, M., Krauter, C., and Goorahoo D., (2005) Ammonia Fluxes from Animal Housing at a California Free Stall Dairy. Presented at the EPA 15th Emissions Inventory Conference, May 15-18, 2006, New Orleans, LA. Technical Paper: https://www3.epa.gov/ttnchie1/conference/ei15/session6/beene.pdf

manure combined with flushing reduced total NH3 emissions from a barn housing cattle by 17-27%.[98]

a) Non-Manure Bedding in Freestall Barns, b) Remove Manure from Freestall Bedding or Management of Freestall Bedding, or c) Have no animals in exercise pens or corrals at any time

Rule 4570 requires dairies and other cattle facilities to implement one of the following mitigation measures to reduce emissions from freestall barns:

a) Use non-manure-based bedding and non-separated solids based bedding for at least 90% of the bedding material, by weight, for freestalls (e.g. rubber mats, almond shells, sand, or waterbeds)

b) Remove manure that is not dry from individual cow freestall beds or rake, harrow, scrape, or grade freestall bedding at least once every seven (7) days for a large Dairy CAF (1,000 milk cows or more) or at least once every fourteen (14) days for a medium Dairy CAF (500 milk cows or more)

c) Have no animals in exercise pens or corrals at any time

Dairies and other cattle facilities that are subject to Rule 4570 must implement one of the practices above or request approval for an alternative mitigation that has been determined by the District, ARB, and EPA to achieve reductions that are equal to or exceed the reductions that would be achieved by complying with the requirements of Rule 4570. Each of the mitigation measures listed above is expected to reduce NH3 emissions. The greatest NH3 reductions would result from option 3, have no corrals animals in corrals or exercise pens at any time. Based on the District NH3 emission factors for dairies approximately 57% of NH3 emissions from dairies are from the corrals and pens. This is because of the very large surface area of corrals/pens where manure is excreted by cattle, which results in greater emissions.

Restricting animals from corrals and pens would reduce the overall area from which NH3 could be emitted and result in increased cleaning of manure excreted in barns. This would significantly reduce NH3 emissions but would not be practical for all dairies because not all cattle facilities have barns, others use different management strategies, and total confinement of cattle without access to exercise areas may also raise concerns about animal health and welfare.

Option 2 above - Use non-manure-based/non-separated solids based bedding would result in the next greatest NH3 reductions. The typical bedding used for cattle in freestall barns is composted/dried separated solids or manure. This manure contains nitrogen that can be emitted as NH3 as the manure decomposes and nitrogenous

[98] 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, https://doi.org/10.1016/j.scitotenv.2016.09.079.

organic matter in the manure mineralizes to non-organic nitrogen. Replacing manure or separated solids based bedding with non-manure, non-separated solids based bedding would eliminate nearly all of the NH3 emissions that result from decomposition of the bedding and the only NH3 emissions from the bedding would be from the fresh manure excreted by the cattle. However, this option is not practical for all dairy facilities because of different management practices and the cost of purchasing and replacing bedding materials in the freestalls barns (e.g. mattresses, sand, etc.)

Option 3 above – Remove manure that is not dry from individual freestall beds or rake, harrow, scrape, or grade freestall beds will also reduce NH3 from freestall bedding by removing manure that emits NH3 when it decomposes and managing the bedding to allow urine to drain away from the bedding. Nitrogen in urine is primarily in the form of urea. Nitrogen from the urea in urine is emitted as NH3 after it has been hydrolyzed to NH3. The conversion of urea to NH3 is catalyzed by the enzyme urease, which is predominantly found in feces. Reducing contact between urine and feces has been shown to be an effective approach to reduce NH3 emissions. In a study by Braam (1997), a floor sloped by 3%, allowing urine to drain away from manure, was found to reduce NH3 emissions by 21%.

a) Clean manure from corrals at least four times per year with at least 60 days between cleaning; or b) Clean corrals at least once between April and July and at least once between September and December

Rule 4570 requires dairies and other cattle facilities to implement one of the following mitigation measures to reduce emissions from corrals/pens:

a) Clean manure from corrals at least four (4) times per year with at least sixty (60) days between cleaning;

b) Clean corrals at least once between April and July and at least once between September and December

Each of the mitigation measures listed above is expected to reduce NH3 emissions. Based on the District NH3 emission factors for dairies, approximately 57% of NH3 emissions from dairies are from corrals and pens. This is because of the very large surface area of corrals/pens where manure is excreted by cattle, which results in greater emissions. Research by Card and Schmidt (2005) supports that management of manure in corrals reduces NH3 emissions from the corrals and points out that of the two dairies tested, the NH3 emissions from the dairy with constantly managed corrals (Dairy 2) had “exceptionally low ammonia emissions”. Follow-up research by Card and Schmidt (2009) at one of the dairies studied (Dairy 1) indicated that NH3 emissions were significantly reduced (> 80% reduction comparing 2008 to 2005 reported NH3 emissions) when the frequency of management of the manure in the corrals was increased.[99]

[99] Schmidt, C. Card, T. (2009) 2008 Dairy Emissions Study: Summary of Dairy Emission Factors and Emission Estimation Procedures. August 2009. Final Report to San Joaquin Valley Air Pollution Control District

a) Slope the surface of the corrals/pens; b) Maintain corrals to ensure proper drainage preventing water from standing; or c) Harrow, rake, or scrape corrals sufficiently to maintain a dry surface

Rule 4570 requires dairies and other cattle facilities to implement one of the following mitigation measures to reduce emissions from corrals/pens:

a) Slope the surface of the corrals at least 3% where the available space for each animal is 400 square feet or less; Slope the surface of the corrals at least 1.5% where the available space for each animal is more than 400 square feet per animal;

b) Maintain corrals to ensure proper drainage preventing water from standing more than forty-eight (48) hours; or

c) Harrow, rake, or scrape corrals and corrals sufficiently to maintain a dry surface, unless the corrals have not held animals in the last thirty (30) days

Proper sloping or management of corrals/pens will reduce NH3 from corral/pens by allowing urine drain away from the corrals/pens. Nitrogen in urine is primarily in the form of urea. As explained above, nitrogen from the urea in urine is emitted as NH3 after it has been hydrolyzed to NH3. The conversion of urea to NH3 is catalyzed by the enzyme urease, which is predominantly found in feces. Reducing contact between urine and feces has been shown to be an effective approach to reduce NH3 emissions. As discussed above, a floor sloped by 3%, allowing urine to drain away from manure, was found to reduce NH3 emissions by 21%.

a) Within 72 hours of removal from housing, either Remove dry manure from the facility or Cover dry manure outside the housing with a weatherproof covering from October through May; or b) Within 72 hours of removal from the drying process, either remove separated solids from the facility; or cover separated solids outside the housing with a weatherproof covering from October through May

Rule 4570 requires large dairy CAFs (at least 1,000 milk cows) and other cattle facilities that handle or store solid manure or separated manure solids outside of the animal housing to implement one of the following mitigation measures (or an approved alternative mitigation measure) to reduce emissions from the solid manure or separated manure solids:

a) Within seventy-two (72) hours of removal from housing, either:
   a. Remove dry manure from the facility; or
   b. 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 twenty-four (24) hours per event.

b) Within seventy-two (72) hours of removal from the drying process, either:

a. Remove separated solids from the facility; or
b. 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 twenty-four (24) hours per event.

Large dairy CAFs and other cattle facilities that are subject to the Rule 4570 must implement one of the practices above or request approval for an alternative mitigation that has been determined by the District, ARB, and EPA to achieve reductions that are equal to or exceed the reductions that would be achieved by complying with the requirements of Rule 4570. Dairies and other cattle facilities may have both scraped solid manure and separated solids and will only be required to implement a mitigation measure for one of these types of solid manure, while beef cattle generally will not have separated solids and must implement a mitigation measure for the solid manure handled outside of corrals. Research by Chadwick (2005) indicated that covering manure piles reduced NH3 emissions by an average of 90%.[100]

a) Incorporate all solid manure within 72 hours of land application; or b) Only apply solid manure that has been treated with an anaerobic treatment lagoon, aerobic lagoon, or digester system; or c) Apply no solid manure with a moisture content of more than 50%

Rule 4570 requires dairies and other cattle facilities that apply solid manure to cropland to implement one of the following mitigation measures (or an approved alternative mitigation measure) to reduce emissions from the land application of solid manure:

a) Incorporate all solid manure within seventy-two (72) hours of land application; or

b) Only apply solid manure that has been treated with an anaerobic treatment lagoon, aerobic lagoon, or digester system; or

c) Apply no solid manure with a moisture content of more than 50%

Dairies and other cattle facilities that are subject to Rule 4570 must implement one of the practices above or request approval for an alternative mitigation that has been determined by the District, ARB, and EPA to achieve reductions that are equal to or exceed the reductions that would be achieved by complying with the requirements of Rule 4570. Based on a review of Valley facilities that Rule 4570 apply to, the mitigation measure that nearly all dairy and other cattle facilities have selected to implement is Mitigation Measure a) *Incorporate all solid manure within 72 hours of land application*. The Alberta, Canada Agriculture and Forestry publication, *Ammonia Volatilization from Manure Application,*[101] indicates average ammonium-nitrogen losses of 35% for manure incorporated in three days compared to 66% for manure that is not incorporated.

[100] Chadwick, D.R. (2005) Emissions of Ammonia, Nitrous Oxide and Methane from Cattle Manure Heaps: Effect of Compaction and Covering. Atmosphere Environment, 39: 787-799. Available at: http://www.sciencedirect.com/science/article/pii/S135223100400994X
[101] Atia, A. (2008). Ammonia volatilization from manure application. Alberta Agriculture, Food and Rural Development.

a) Only apply liquid manure that has been treated with an anaerobic treatment lagoon, aerobic lagoon, or digester system; or b) Allow liquid manure to stand in the fields for no more than twenty-four (24) hours after irrigation; or c. Apply liquid/slurry manure via injection with drag hose or similar apparatus

Rule 4570 requires dairies and other cattle facilities that apply liquid manure to cropland to implement one of the following mitigation measures (or an approved alternative mitigation measure) to reduce emissions from the land application of liquid manure:

a) Only apply liquid manure that has been treated with an anaerobic treatment lagoon, aerobic lagoon, or digester system; or

b) Allow liquid manure to stand in the fields for no more than twenty-four (24) hours after irrigation; or

c) Apply liquid/slurry manure via injection with drag hose or similar apparatus

Dairies and other cattle facilities that are subject to Rule 4570 must implement one of the mitigation measures above or request approval for an alternative mitigation that has been determined by the District, ARB, and EPA to achieve reductions that are equal to or exceed the reductions that would be achieved by complying with the requirements of Rule 4570.

The actual NH3 emissions from the application of liquid manure in the San Joaquin Valley are expected to be minimal because of the typical practices that are utilized when applying liquid manure in the San Joaquin Valley. The report, *Managing Dairy Manure in the Central Valley of California,* prepared by the University of California Division of Agricultural and Natural Resources Committee of Experts on Dairy Manure Management (2005) indicates that in California “nearly all” manure from lagoons used for land application 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% or less).”

For application of liquid manure, the mitigation measure that nearly all dairy and other cattle facilities have selected to implement is Mitigation Measure b) *Allow liquid manure to stand in the fields for no more than 24 hours after irrigation*. This is because, in comparison, the other options are more costly and difficult to implement. In addition, for many facilities implementation of the other options is impractical. There are few cattle facilities with properly designed anaerobic treatment lagoons, and no lagoons for dairy manure operating in the San Joaquin Valley have been identified that satisfy the requirements for aerobic treatment lagoons as specified in District Rule 4570. As mentioned above, there are approximately a dozen anaerobic digesters currently operating in the San Joaquin Valley, so this option is not feasible due to the large number of dairies in the San Joaquin Valley.

Application of liquid or slurry manure with a drag hose or similar apparatus could result in significant NH3 reductions, but has higher costs compared to flood or furrow irrigation of liquid manure. This practice is not currently common and is not feasible during times when a crop is growing. Therefore, it will be conservatively assumed that all dairies and other cattle facilities implement Mitigation Measure b) Allow liquid manure to stand in the fields for no more than 24 hours after irrigation. In order for liquid manure to remain standing in the field for no more than 24 hours, it must infiltrate the crop soil within this time and this can be assumed to be approximately equivalent to incorporation of the liquid manure. The Alberta, Canada Agriculture and Forestry publication, *Ammonia Volatilization from Manure Application*,[102] indicates average ammonium-nitrogen losses of 25% for manure incorporated in one day, compared to 66% for manure that is not incorporated. At a San Joaquin Valley dairy measured during a 2008 dairy emissions study by Schmidt, the net NH3 emissions from liquid manure application up to 24 hours were approximately 46% of total net NH3 emissions from liquid manure application (up to 100 hours).[103] This indicates an overall reduction of approximately 54% if liquid manure applied to land completely infiltrates the soil within 24 hours.

The analysis below focuses on how District Rule 4570 limits NH3 emissions in comparison to other rules and regulations.

How does District Rule 4570 compare with federal and state rules and regulations?

Federal requirements such as NSPS, NESHAP, MACT, CTGs, and ACTs and state regulations are not applicable to this source category.

How does District Rule 4570 compare to rules in other air districts?

As the largest agricultural area in California, the District took the lead in devising a list of mitigation measures for the various emission sources during the initial development of District Rule 4570. This list of mitigation measures was essentially utilized, almost identically, by all air districts in their rules. However, during the last amendments to District Rule 4570, all of the mitigation measures were reevaluated in light of the latest available science. In comparison to the previous version of the rule, the current rule lowered threshold limits to bring in additional CAFs, requires additional mitigation measures, clarified previous mitigation measures, and added additional monitoring, testing, and recordkeeping to improve enforceability.

The following California air district rules were compared to District Rule 4570:

- SCAQMD Rule 223, adopted June 2, 2006
- SCAQMD Rule 1127, adopted August 6, 2004
- BAAQMD Regulation 2 Rule 10, adopted July 19, 2006
- VCAPCD Rule 23 (Exemptions), amended November 12, 2013
- SMAQMD Rule 496, adopted August, 24, 2006

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[102] Atia, A. (2008). Ammonia volatilization from manure application. Alberta Agriculture, Food and Rural Development.
[103] Chadwick, D.R. (2005) Emissions of Ammonia, Nitrous Oxide and Methane from Cattle Manure Heaps: Effect of Compaction and Covering. Atmosphere Environment, 39: 787-799. Available at: http://www.sciencedirect.com/science/article/pii/S135223100400994X

- Imperial County APCD (ICAPCD) Rule 217 and Policy Number 38, adopted February 9, 2016

Idaho Administrative Procedure Act (IDAPA) 58.01.01 Sections 760-764 was also compared with District Rule 4570 and the analysis is shown below.

It is important to note that only District Rule 4570, SMAQMD Rule 496, and SCAQMD Rule 1127 are prohibitory rules. For this reason, these rules include detailed recordkeeping as well as monitoring and testing requirements. Generally, the level of detail in a prohibitory rule is absent from permits rules because the purpose of a permit rule is different from the purpose of a prohibitory rule.

South Coast AQMD

- SCAQMD Rule 223 (Emission Reduction Permits for Large Confined Animal Facilities) *(Adopted June 2, 2006)*

Based on the analysis of the CAF categories in District Rule 4570 and SCAQMD Rule 223, it is clear that District Rule 4570 is more stringent than SCAQMD Rule 223. District Rule 4570 requires facilities to choose more mitigation measures and makes several mitigation measures mandatory.

District Rule 4570 also provides mitigation for more CAF categories (beef feedlots, other cattle, and swine) that are not addressed by SCAQMD Rule 223, and also has much more detailed recordkeeping requirements to demonstrate implementation of selected mitigation measures.

	SJVAPCD Rule 4570	SCAQMD Rule 223	Conclusion
Applicability	Applies to large CAFs as defined by ARB. Requirements apply to horse facilities with at least 3,000 head In addition to Large CAFs, also applies to Dairies with at least 500 milk cows (Large CAF threshold 1,000 milk cows) and Broiler, Duck, and Layer facilities with at least 400,000 birds (Large CAF threshold 650,000 birds)	Applies to large CAFs as defined by ARB Defines a large CAF for horses as having at least 2,500 head (Note: There are currently no CAFs in the SJV with at least 2,500 horses and no horse CAFs in the SJV are expected to exceed this threshold in the foreseeable future)	Rule 4570 is more stringent regarding applicability

Requirements for Dairy CAFs		
	SJVAPCD Rule 4570	**SCAQMD Rule 223**
Requirements: Feed Mitigation Measures	Operators must implement four mandatory feed mitigation measures and chose one other option from a list of three, for a total of five feed mitigation measures	Nine optional feed mitigation measures, from which an operator must choose five to implement

Requirements: Milk Parlor Mitigation Measures	Flush or hose milking parlor immediately prior to, immediately after, or during each milking. Class Two mitigation measures removed due to infeasibility (see the Staff Report for the October 21, 2010 amendments to Rule 4570 for more detail)	Includes option of choosing one class 1 measure (Flush or hose milking parlor immediately prior to, immediately after, or during each milking) or one Class 2 measure
Requirements: Freestall Mitigation Measures	Operators must implement a total of three mitigation measures - two mandatory mitigation measures and choose one additional measure from three possible options	Operators must choose to implement two mitigation measures from eight possible options
Requirements: Corral Mitigation Measures	Operators must implement a total of seven mitigation measures – six mandatory mitigation measures and choose one additional measure from three possible options	Operators must choose to implement six mitigation measures from 14 possible Class One mitigation measures and two possible Class Two mitigation measures
Requirements: Solid Manure and Separated Solids Mitigation Measures	Operators must choose to implement at least one mitigation measure from two possible options	Operators must implement two mitigation measures chosen from three possible Class One mitigation measures and three possible Class Two mitigation measures. However, for practical purposes only one mitigation measure must be implemented. The Class one mitigation measures include: 1) Covering dry manure piles outside the pens with a waterproof covering from October through May, 2) Covering dry separated solids outside the pens with a waterproof covering from October through May, and 3) Removal of manure from the facility within seventy-two (72) hours of removal from the pens or corrals. Dairies in the SCAQMD are generally dry scrape dairies and will not have separated solids and many dairies store manure in the pens until it can be removed for use as fertilizer or compost.
Requirements: Liquid Manure Mitigation Measures	Operators must choose to implement at least one mitigation measure from four possible options	Operators must choose to implement one mitigation measures from five possible Class One mitigation measures and five possible Class Two mitigation measures
Requirements: Manure Land Application Mitigation Measures	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options	Operators must choose to implement two mitigation measures from four possible options

Requirements for Poultry CAFs		
	SJVAPCD Rule 4570	**SCAQMD Rule 223**

Requirements: Feed Operations	Operators must choose to implement one feed mitigation measure from four possible options	Operators must choose to implement five mitigation measures from six possible options
Requirements: Poultry Housing	Operators required to implement two mitigation measures for layers, four mitigation measures for broilers or ducks, and five mitigation measures for turkeys	Operators must choose to implement four mitigation measures from 11 possible Class One mitigation measures and two possible Class Two mitigation measures
Requirements: Solid Manure or Separated Solids	Operators must choose to implement one mitigation measure	Operators must choose to implement one mitigation measures from three possible Class One mitigation measures and three possible Class Two mitigation measures
Requirements: Liquid Manure	Operators that handle manure in liquid form must choose to implement one mitigation measure	Operators that handle manure in liquid form must choose to implement one mitigation measures from four possible Class One mitigation measures and three possible Class Two mitigation measures

Requirements for Other CAF Categories		
	SJVAPCD Rule 4570	**SCAQMD Rule 223**
Requirements:	District Rule 4570 provides specific mitigation measures for beef cattle feedlots, other cattle, and swine CAFs	SCAQMD Rule 223 does not address mitigation measures for beef cattle feedlots, other cattle, and swine CAFs

Suspension and Substitution of Mitigation Measures		
	SJVAPCD Rule 4570	**SCAQMD Rule 223**
Requirements:	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure

South Coast AQMD

- SCAQMD Rule 1127 (Emission Reductions from Livestock Waste) *(Adopted August 6, 2004)*

For dairy CAFs, District Rule 4570 is more stringent than SCAQMD Rule 1127. District Rule 4570 requires emission reductions from additional emission categories that are not addressed by SCAQMD Rule 1127 (e.g. milk parlors, freestall barns, and liquid manure), as well as requiring emission reductions from CAFs from other animal species. District Rule 4570 exemption is more stringent because it is only a temporary suspension that cannot exceed 30 days, whereas SCAQMD Rule 1127's exemption may be permanent, without requiring substitution of another measure. District Rule 4570 requires facilities to choose more mitigation measures and makes several mitigation measures mandatory. District Rule 4570 also provides specific mitigation measures for beef cattle feedlots, other cattle, poultry, and swine CAFs, while SCAQMD Rule 1127 does not. District Rule 4570 is therefore more stringent than SCAQMD Rule 1127.

	SJVAPCD Rule 4570	SCAQMD Rule 1127
Applicability	Applies to dairy CAFs with at least 500 milking cows; Also applies to other CAFs, Applies to more than just manure-handling	Applies to dairies with 50 or more cows, heifers, and/or calves. Applies to dairy farms and related operations such as heifer and calf farms and the manure produced on them

Requirements for Dairy CAFs		
	SJVAPCD Rule 4570	**SCAQMD Rule 1127**
Requirements: Milking Parlor and Freestall Mitigation Measures	For milking parlors, operators must implement one mandatory mitigation measure For Freestalls, operators must implement a total of three mitigation measures - two mandatory mitigation measures and choose one additional measure from three possible options	No requirements for milking parlors and freestalls
Requirements: Corral Mitigation Measures	Operators must implement a total of seven mitigation measures – six mandatory mitigation measures and choose one additional measure from three possible options	Mitigation measures required by SCAQMD Rule 1127 specify the removal of manure from the corrals, the minimization of water in the corrals, and the cleaning schedule and cleaning strategy for the corrals
Requirements: Mitigation Measures For Solid Manure, Separated Solids, Liquid Manure, and Manure Land Application	Operators must choose one mitigation measure for solid manure/separated solids, one mitigation measure for liquid manure, and one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application	SCAQMD Rule 1127 requires that manure removed must be either treated at an approved manure processing operation, or applied on agricultural land with local approval. SCAQMD Rule 1127 does not specify mitigation measures for solid manure, separated solids, or liquid manure

Requirements: Corral Mitigation Measures	Operators must implement a total of seven mitigation measures – six mandatory mitigation measures and choose one additional measure from three possible options	Operators must choose to implement six mitigation measures from 14 possible Class One mitigation measures and two possible Class Two mitigation measures
Requirements: Solid Manure and Separated Solids Mitigation Measures	Operators must choose to implement at least one mitigation measure from two possible options	Operators must implement two mitigation measures chosen from three possible Class One mitigation measures and three possible Class Two mitigation measures. However, for practical purposes only one mitigation measure must be implemented. The Class one mitigation measures include: 1) Covering dry manure piles outside the pens with a waterproof covering from October through May, 2) Covering dry separated solids outside the pens with a waterproof covering from October through May, and 3) Removal of manure from the facility within seventy-two (72) hours of removal from the pens or corrals. Dairies in the SCAQMD are generally dry scrape dairies and will not have separated solids and many dairies store manure in the pens until it can be removed for use as fertilizer or compost.

Requirements for Other CAF Categories		
	SJVAPCD Rule 4570	**SCAQMD Rule 1127**
Requirements:	District Rule 4570 provides specific mitigation measures for beef cattle feedlots, other cattle, poultry, and swine CAFs	SCAQMD Rule 223 does not address mitigation measures for beef cattle feedlots, poultry, and swine CAFs

Suspension and Substitution of Mitigation Measures		
	SJVAPCD Rule 4570	**SCAQMD Rule 1127**
Requirements:	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure	Allows one exemption per year from one of the corral clearings required every 90 days if the moisture content in the corrals is greater than 50%. The operator is required to notify SCAQMD 30 days before the required cleaning, and test moisture content weekly.

Bay Area AQMD

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

District Rule 4570 requires facilities to choose specific mitigation measures and makes several mitigation measures mandatory. In addition, District Rule 4570 has lower applicability thresholds for dairies, chickens, and ducks. Based on this information and the discussion above, District Rule 4570 is far more stringent than BAAQMD Rule 2-10.

	SJVAPCD Rule 4570	BAAQMD Rule 2-0
Applicability	Applies to large CAFs as defined by ARB. Requirements apply to horse facilities with at least 3,000 head In addition to Large CAFs, also applies to Dairies with at least 500 milk cows (Large CAF threshold 1,000 milk cows) and Broiler, Duck, and Layer facilities with at least 400,000 birds (Large CAF threshold 650,000 birds)	Applies to large CAFs as defined by ARB Defines a large CAF for horses as having at least 2,500 head (Note: There are currently no CAFs in the SJV with at least 2,500 horses and no horse CAFs in the SJV are expected to exceed this threshold in the foreseeable future)

Requirements for CAFs		
	SJVAPCD Rule 4570	**BAAQMD Rule 2-0**
Requirements:	Requires specific mitigation measures for various emission sources (e.g. feed, housing, manure handling, etc.) for the different types of CAFs	Requires permit conditions that implement control measures that represent Reasonably Available Control Technology (RACT) to reduce emissions of VOC, NOx and PM from the facility Currently no CAFs subject to rule and no approved list of RACT measures that must be implemented

Ventura County APCD

- VCAPCD Rule 23 (Exemptions from Permit) *(Amended November 11, 2013)*

In response to California Senate Bill (SB) 700, VCAPCD revised its "Exemptions from Permit" rule to remove an exemption for agricultural operations, including CAFs. VCAPCD does not have a specific rule for CAFs. In its staff report for the rule revision, VCAPCD staff noted that no facilities in their jurisdiction would meet the "large CAF" definition and there was no expectation that a large CAF would move into the area in the foreseeable future; therefore, no separate CAF rule was necessary. VCAPCD does not have a specific rule for CAFs; therefore, District Rule 4570 is more stringent.

	SJVAPCD Rule 4570	VCAPCD Rule 23
Applicability	Applies to large CAFs as defined by ARB. Requirements apply to horse facilities with at least 3,000 head In addition to Large CAFs, also applies to Dairies with at least 500 milk cows (Large CAF threshold 1,000 milk cows) and Broiler, Duck, and Layer facilities with at least 400,000 birds (Large CAF threshold 650,000 birds)	Adopted ARBs definition of large CAFs Defines a large CAF for horses as having at least 2,500 head (Note: There are currently no CAFs in the SJV with at least 2,500 horses and no horse CAFs in the SJV are expected to exceed this threshold in the foreseeable future)

Requirements for CAFs		
	SJVAPCD Rule 4570	**VCAPCD Rule 23**
Requirements:	Requires specific mitigation measures for various emission sources (e.g. feed, housing, manure handling, etc.) for the different types of CAFs	No specific requirements or rules for CAFs There are currently no facilities in VCAPCD that are large CAFs and no large CAF is expected to move into the area in the foreseeable future; therefore, VCAPCD determined no separate CAF rule was necessary

Sacramento Metro AQMD

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

District Rule 4570 is more stringent than SMAQMD Rule 496 because District Rule 4570 requires emission reductions from four additional emission categoriesat dairy CAFs - milk parlors, feed, freestall barns, and liquid manure - that are not addressed by SMAQMD Rule 496 as well as having specific requirements for other types of CAFs. District Rule 4570 also requires facilities to choose more mitigation measures and mandates several mitigation measures. In addition, Rule 4570 applies to dairies with greater than 500 milk cows and 400,000 layers and broilers while SMAQMD Rule 496 applies to dairies with 1,000 milk cows or more and broiler and layer operations with more than 650,000 birds.

	SJVAPCD Rule 4570	SMAQMD Rule 496
Applicability	Applies to large CAFs as defined by ARB. Requirements apply to horse facilities with at least 3,000 head In addition to Large CAFs, also applies to Dairies with at least 500 milk cows (Large CAF threshold 1,000 milk cows) and Broiler, Duck, and Layer facilities with at least 400,000 birds (Large CAF threshold 650,000 birds)	Applies to large CAFs as defined by ARB Defines a large CAF for horses as having at least 2,500 head (Note: There are currently no CAFs in the SJV with at least 2,500 horses and no horse CAFs in the SJV are expected to exceed this threshold in the foreseeable future)

Requirements for Dairy CAFs		
	SJVAPCD Rule 4570	**SMAQMD Rule 496**
Requirements: Feed Mitigation Measures	Operators must implement four mandatory feed mitigation measures (excluding silage) and chose one other option from a list of three, for a total of five feed mitigation measures	Nine optional feed mitigation measures (excluding silage), from which an operator must choose to implement four feed mitigation measures. Operators must also choose one silage mitigation measure
Requirements: Milk Parlor Mitigation Measures	Flush or hose milking parlor immediately prior to, immediately after, or during each milking. Class Two mitigation measures removed due to infeasibility (see the Staff Report for the October 21, 2010 amendments to Rule 4570 for more detail)	Includes option of choosing one class 1 measure (Flush or hose milking parlor immediately prior to, immediately after, or during each milking) or one Class 2 measure
Requirements: Freestall Mitigation Measures	Operators must implement a total of three mitigation measures - two mandatory mitigation measures and choose one additional measure from three possible options	Operators must choose to implement two mitigation measures from eight possible Class One mitigation measure options and two possible Class Two mitigation measure options
Requirements: Corral Mitigation Measures	Operators must implement a total of seven mitigation measures – six mandatory mitigation measures and choose one additional measure from three possible options	Operators must choose to implement six mitigation measures from 15 possible Class One mitigation measure options and three possible Class Two mitigation measure options
Requirements: Solid Manure and Separated Solids Mitigation Measures	Operators must choose to implement at least one mitigation measure from two possible options	Operators must implement two mitigation measures chosen from three possible Class One mitigation measures and three possible Class Two mitigation measures.
Requirements: Liquid Manure Mitigation Measures	Operators must choose to implement at least one mitigation measure from four possible options	Operators must choose to implement one mitigation measures from four possible Class One mitigation measures and four possible Class Two mitigation measures

Requirements: Manure Land Application Mitigation Measures	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options	Operators must choose to implement two mitigation measures from four possible options

Requirements for Poultry CAFs		
	SJVAPCD Rule 4570	**SMAQMD Rule 496**
Requirements: Feed Operations	Operators must choose to implement one feed mitigation measure from four possible options	Operators must choose to implement five mitigation measures from nine possible options
Requirements: Poultry Housing	Operators are required to implement two mitigation measures for layers, four mitigation measures for broilers or ducks, and five mitigation measures for turkeys	Operators must choose to implement four mitigation measures from 16 possible options
Requirements: Solid Manure or Separated Solids	Operators must choose to implement one mitigation measure	Operators must choose to implement one mitigation measures from three possible Class One mitigation measures and two possible Class Two mitigation measures
Requirements: Liquid Manure	Operators that handle manure in liquid form must choose to implement one mitigation measure	Operators that handle manure in liquid form must choose to implement one mitigation measures from four possible Class One mitigation measures and three possible Class Two mitigation measures

Requirements for Other CAF Categories		
	SJVAPCD Rule 4570	**SMAQMD Rule 496**
Requirements:	District Rule 4570 provides specific mitigation measures for beef cattle feedlots, other cattle, and swine CAFs	SMAQMD Rule 496 does not address mitigation measures for beef cattle feedlots, other cattle, and swine CAFs

Suspension and Substitution of Mitigation Measures		
	SJVAPCD Rule 4570	**SMAQMD Rule 496**
Requirements:	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure

Imperial County APCD

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

ICAPCD Rule 217 indicates that the purpose of the rule is to limit emissions of VOCs and NH3 from Large Confined Animal Facilities. ICAPCD Rule 217 was originally adopted on October 10, 2006, but was recently amended on February 9, 2016. The amendments were intended to address deficiencies that US EPA and ARB identified in the rule as originally adopted and resulted in requirements that were essentially identical to District Rule 4570, which had already been approved for inclusion in the State Implementation Plan (SIP). District Rule 4570 and ICAPCD Rule 217 contain fundamentally identical requirements and therefore are of equal stringency.

	SJVAPCD Rule 4570	ICAPCD Rule 217
Applicability	Applies to the Large CAFs and other Confined Animal Facilities with the following numbers of animals: • Dairy: 500 Milk Cows • Beef Feedlots: 3,500 Beef Cattle • Other Cattle: 7,500 cattle • Chickens: 400,000 birds • Ducks: 400,000 birds • Turkeys: 100,000 birds • Swine: 3,000 head • Horses: 3,000 head • Sheep and Goats: 15,000 head • Other: 30,000 head	Applies to the Large CAFs and other Confined Animal Facilities with the following numbers of animals: • Dairy: 500 Milk Cows • Beef Feedlots: 3,500 Beef Cattle • Other Cattle: 3,500 cattle • Chickens: 400,000 birds • Ducks: 400,000 birds • Turkeys: 100,000 birds • Swine: 3,000 head • Horses: 2,500 head • Sheep and Goats: 15,000 head • Other: 30,000 head (Note: There are currently no CAFs in the SJV with at least 2,500 horses and no horse CAFs in the SJV are expected to exceed this threshold in the foreseeable future)

Requirements for Dairy CAFs		
	SJVAPCD Rule 4570	**ICAPCD Rule 217**
Requirements: Feed Mitigation Measures	Operators must implement four mandatory feed mitigation measures (excluding silage) and chose one other option from a list of three, for a total of five feed mitigation measures	Operators must implement four mandatory feed mitigation measures (excluding silage) and chose one other option from a list of three, for a total of five feed mitigation measures
Requirements: Milk Parlor Mitigation Measures	Flush or hose milking parlor immediately prior to, immediately after, or during each milking.	Flush or hose milking parlor immediately prior to, immediately after, or during each milking.
Requirements: Freestall Mitigation Measures	Operators must implement a total of three mitigation measures - two mandatory mitigation measures and choose one additional measure from three possible options	Operators must implement a total of three mitigation measures - two mandatory mitigation measures and choose one additional measure from three possible options
Requirements: Corral Mitigation Measures	Operators must implement a total of seven mitigation measures – six mandatory mitigation measures and choose one additional measure from three possible options	Operators must implement a total of seven mitigation measures – six mandatory mitigation measures and choose one additional measure from three possible options

Requirements: Solid Manure and Separated Solids Mitigation Measures	Operators must choose to implement at least one mitigation measure from two possible options	Operators must choose to implement at least one mitigation measure from two possible options
Requirements: Liquid Manure Mitigation Measures	Operators must choose to implement at least one mitigation measure from four possible options	Operators must choose to implement at least one mitigation measure from four possible options
Requirements: Manure Land Application Mitigation Measures	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options

Requirements for Beef CAFs		
	SJVAPCD Rule 4570	**ICAPCD Rule 217**
Requirements: Feed Mitigation Measures	Operators must implement two feed mitigation measures from four possible options	Operators must implement two feed mitigation measures from four possible options
Requirements: Housing Mitigation Measures	Operators must implement a total of five mitigation measures - four mandatory mitigation measures and choose one additional measure from two possible options	Operators must implement a total of five mitigation measures - four mandatory mitigation measures and choose one additional measure from two possible options
Requirements: Solid Manure and Separated Solids Mitigation Measures	Operators must choose to implement at least one mitigation measure from two possible options	Operators must choose to implement at least one mitigation measure from two possible options
Requirements: Liquid Manure Mitigation Measures	Operators must choose to implement at least one mitigation measure from four possible options	Operators must choose to implement at least one mitigation measure from four possible options
Requirements: Manure Land Application Mitigation Measures	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options

Requirements for Other Cattle CAFs		
	SJVAPCD Rule 4570	**ICAPCD Rule 217**
Requirements: Feed Mitigation Measures	Operators must implement two feed mitigation measures from four possible options	Operators must implement two feed mitigation measures from four possible options
Requirements: Freestall Mitigation Measures	Operators must implement a total of three mitigation measures - two mandatory mitigation measures and choose one additional measure from two possible options	Operators must implement a total of three mitigation measures - two mandatory mitigation measures and choose one additional measure from two possible options

Requirements: Corral Mitigation Measures	Operators must implement a total of six mitigation measures – five mandatory mitigation measures and choose one additional measure from three possible options	Operators must implement a total of six mitigation measures – five mandatory mitigation measures and choose one additional measure from three possible options
Requirements: Solid Manure and Separated Solids Mitigation Measures	Operators must choose to implement at least one mitigation measure from two possible options	Operators must choose to implement at least one mitigation measure from two possible options
Requirements: Liquid Manure Mitigation Measures	Operators must choose to implement at least one mitigation measure from four possible options	Operators must choose to implement at least one mitigation measure from four possible options
Requirements: Manure Land Application Mitigation Measures	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options	Operators must choose to implement one mitigation measure for solid manure land application and one mitigation measure for liquid manure land application measures from six possible options

Requirements for Swine CAFs		
	SJVAPCD Rule 4570	**ICAPCD Rule 217**
Requirements: Feed Mitigation Measures	Operators must implement two feed mitigation measures	Operators must implement two feed mitigation measures
Requirements: Housing Mitigation Measures	Operators must implement three housing mitigation measures	Operators must implement three housing mitigation measures
Requirements: Liquid Manure Mitigation Measures	Operators must implement one liquid manure mitigation measures	Operators must implement one liquid manure mitigation measures
Requirements: Manure Land Application Mitigation Measures	Operators must choose to implement one mitigation measure for manure land application	Operators must choose to implement one mitigation measure for manure land application

Requirements for Poultry CAFs		
	SJVAPCD Rule 4570	**ICAPCD Rule 217**
Requirements: Feed Operations	Operators must choose to implement one feed mitigation measure from four possible options	Operators must choose to implement one feed mitigation measure from four possible options
Requirements: Poultry Housing	Operators are required to implement two mitigation measures for layers, four mitigation measures for broilers or ducks, and five mitigation measures for turkeys	Operators are required to implement two mitigation measures for layers, four mitigation measures for broilers or ducks, and five mitigation measures for turkeys
Requirements: Solid Manure or Separated Solids	Operators must choose to implement one mitigation measure	Operators must choose to implement one mitigation measure

Requirements: Liquid Manure	Operators that handle manure in liquid form must choose to implement one mitigation measure	Operators that handle manure in liquid form must choose to implement one mitigation measure

Suspension and Substitution of Mitigation Measures		
	SJVAPCD Rule 4570	**ICAPCD Rule 217**
Requirements:	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure

Idaho Administrative Procedure Act (IDAPA)

- ***IDAPA 58.01.01 Sections 760-764 (Rules for the Control of Ammonia from Dairy Farms)***

IDAPA 58.01.01 Sections 760-763 was adopted on March 30, 2007 and IDAPA 58.01.01 Subsection 764.02: Table – Ammonia Control Practices for Idaho Dairies was last amended on May 8, 2009.

Pursuant to IDAPA 58.01.01 Section 761, Sections 760-764 apply to dairies of the following sizes. The thresholds are based on estimating the number of cattle required to produce 100 tons of ammonia emissions annually. Different thresholds are given for drylot dairies, dairies with scraped freestalls, and dairies with flushed freestalls.

District Rule 4570 is far more stringent than IDAPA 58.01.01 Sections 760-764. Unlike IDAPA 58.01.01 Sections 760-764, District Rule 4570 requires specific practices for the various operations at dairies. District Rule 4570 exemption is more stringent because it is a temporary suspension that cannot exceed 30 days, whereas the IDAPA 58.01.01 Sections 760-764 exemption may last one year, without any requirement to substitute another measure. District Rule 4570 also provides specific mitigation measures for beef cattle feedlots, other cattle facilities, poultry facilities, and swine facilities, while IDAPA 58.01.01 Sections 760-764 does not.

	SJVAPCD Rule 4570	IDAPA 58.01.01 Sections 760-764
Applicability	Applies to the Large CAFs and other Confined Animal Facilities with the following numbers of animals: • Dairy: 500 Milk Cows • Beef Feedlots: 3,500 Beef Cattle • Other Cattle: 7,500 cattle • Chickens: 400,000 birds • Ducks: 400,000 birds • Turkeys: 100,000 birds • Swine: 3,000 head • Horses: 3,000 head • Sheep and Goats: 15,000 head • Other: 30,000 head	Applies to dairies with the following number of cattle: • Drylot Dairy: minimum of 4,589 milk cow equivalents • Freestall Scrape Dairy: minimum of 2,643 milk cow equivalents • Freestall Flush Dairy: minimum of 1,638 milk cow equivalents

Requirements for Dairy CAFs		
	SJVAPCD Rule 4570	**IDAPA 58.01.01 Sections 760-764**
Requirements:	District Rule 4570 requires specific mitigation measures to address emissions from various sources at dairies (e.g. milking parlor, corrals, freestalls, manure management, and manure land application)	Must employ Best Management Practices (BMPs) (e.g. solid separation, corral cleaning, composting, etc.)

Requirements for Other CAF Categories		
	SJVAPCD Rule 4570	**IDAPA 58.01.01 Sections 760-764**
Requirements:	District Rule 4570 provides specific mitigation measures for beef cattle feedlots, other cattle, swine, and poultry CAFs	IDAPA 58.01.01 Sections 760- 764 only applies to dairies and does not apply to beef cattle feedlots, other cattle, swine, or poultry CAFs

Suspension and Substitution of Mitigation Measures		
	SJVAPCD Rule 4570	**IDAPA 58.01.01 Sections 760-764**
Requirements:	Allows temporary suspension of a mitigation measure upon the determination by a certified veterinarian or nutritionist that such a suspension is necessary for animal health purposes. The District must be notified within 48 hours, and a new measure must be implemented if the suspension is expected to last longer than 30 days. Allows for substitution of one mitigation measure with an equivalent or more stringent measure	Allows exemption for up to one year for a dairy that become subject to the rule as a result of an emergency for example if a dairy farmer takes additional cows due to unforeseen circumstances)

Additional Emission Reduction Opportunities

Recent studies have cited the episodic application of sodium bisulfate (SBS) onto manure at dairies as a potential control strategy to reduce ammonia emissions.

SCAQMD included a potential control measure within their 2012 Air Quality Management Plan (AQMP) to evaluate the use of SBS at dairies to determine the technical and economic feasibility of its application in reducing ammonia emissions as well as potential impacts to groundwater. The District did not find any agency requiring the use of SBS. The District has evaluated SBS as a potential control measure and determined that for a variety of reasons that this control strategy is infeasible and ineffective for reducing PM2.5 concentrations in the Valley.

SBS is an acid salt that has been used to reduce pH and bacterial levels in the bedding for dairy cattle. Application of SBS on fresh manure or corral surfaces has the potential to reduce ammonia emissions by reducing the pH of the manure or corral surface. With a lower pH, a greater fraction of the ammonia is converted to non-volatile ammonium (NH4+). The ammonium combines with sulfate to form ammonium sulfate, which is retained in the manure or on the surface of the corral.

There are a number of potential issues that need to be considered related to the application of SBS at dairies including, but not limited to, the health and safety of dairy workers and dairy cattle, impacts on water quality, and overall cost and effectiveness. The SCAQMD 2012 AQMP states: that potential use of SBS would be specific to dairies in the SCAQMD and may be unique to localized operations, that “the requirements may not be applicable to dairies elsewhere where a site-specific assessment would need to be made relative to those particular conditions”, and that it is likely that each air district would need to conduct an assessment as to the feasibility of SBS application in their jurisdiction.

The SCAQMD AQMP focuses on episodic controls to reduce ammonia emissions during periods of high PM2.5 concentrations. PM concentrations in the Valley are highest during the winter season (November – February). Unlike the SCAQMD where the majority of dairies are open corral facilities, most dairies in the Valley utilize a freestall design and generally restrict the cows’ access to corrals during the winter months since the corrals are wet and muddy. As a result, there would be very little to no fresh manure excreted in corrals during the winter period. In addition, once wet conditions set in, it is not feasible to utilize tractors in the corrals to apply SBS since the tractors tend to get stuck in mud. Application by hand at large dairies would be very labor intensive, time consuming, extremely costly, and would potentially pose health and safety risks to the workers.

Although SBS is generally considered to be safe in small quantities, excessive loading of salts is a major water quality concern in the central and southern regions of the Valley where many dairies are located. A dairy would also need to work with the Regional Water Quality Control Board to determine if the application of SBS is allowed. In addition, applying SBS to corrals, which for many dairies can be greater than several acres in size, is not practical or feasible. Also, because flush dairies are common in the Valley (both freestall and open corral), the heavy use areas will generally be paved, and frequent flushing of the freestall or corral lanes (as required by Rule 4570) already significantly reduces ammonia emissions; therefore, application of SBS to only these areas would not provide significant additional reductions in ammonia emissions. By design, SBS will be flushed to a lagoon or pond where the high buffering capacity would render it ineffective and possibly increase H2S emissions.

There are significant costs associated with the application of SBS. Iowa State University Extension estimates the costs of SBS to be $660/ton. District estimates show that 1,304 lb-1,955 lb/cow-yr of SBS would be needed for application to one entire corral area, costing $430-$645/cow-yr. Using the District's corral ammonia emission factor for milk cows and assuming a conservatively high estimate of 50% reduction in overall ammonia emissions, the cost of the ammonia reductions would be at least $41,067/ton to $61,601/ton or higher depending on corral size. Applying SBS to large areas also requires significant amounts of SBS to be applied. The application of SBS will also be short lived and conflict with requirements from Rule 4550 which requires dairies to scrape their corrals on a frequent basis at least once every two weeks, making the application of SBS ineffective and costly due to the constant need to reapply. Information from Iowa State shows reduced costs of $129-$193/cow-yr for only treating heavy use areas, such as feed bunks and water troughs. It is not clear how much manure is excreted in heavy use areas, but even if the resulting cost per ton of reduction was cut in half, the costs would still be significant.

Due to the barriers to widespread implementation of SBS application to Valley cattle facilities, as well as the high costs of effective application to control ammonia emissions, the application of SBS is not a feasible regulatory requirement.

Evaluation Findings

While BACM and MSM requirements do not apply to ammonia since it is not a significant precursor to PM2.5 formation in the Valley, District staff concludes that District Rule 4570 meets BACM and MSM requirements for ammonia emissions from CAFs. The District evaluated the feasibility of additional ammonia emissions reductions and did not identify any additional feasible measures.

Ammonia Emissions from Agricultural Fertilizer

The District does not have statutory authority to regulate the application of agricultural fertilizers. However, in recent years, California has begun increasing efforts to improve the efficiency of nitrogen usage to minimize environmental impacts from the use of fertilizers and manure in California agriculture. One of the primary drivers for these efforts is to reduce nitrate contamination in groundwater. An additional goal of these efforts is to minimize losses of reactive nitrogen to the atmosphere through volatilization. As part of the efforts to improve the efficiency of nitrogen use in California, the University of California, Davis, Agricultural Sustainability Institute produced the report The California Nitrogen Assessment: Challenges and Solutions for People, Agriculture, and the Environment.[104] The California Nitrogen Assessment began in 2009 with goals of providing insights into balancing the benefits of nitrogen in California's modern economy, including agriculture, and the effects of surplus nitrogen in the environment and

[104] Tomich, T. P., Brodt, S. B., Dahlgren, R. A., & Scow, K. M. (Eds.). (2016). The California Nitrogen Assessment: Challenges and solutions for people, agriculture, and the environment. Univ of California Press. Executive summary available at: http://asi.ucdavis.edu/programs/sarep/research-initiatives/are/nutrient-mgmt/california-nitrogen-assessment/ExecutiveSummaryLayout_FINAL_reduced.pdf

comparing options to improve the management of nitrogen and mitigate the negative impacts of surplus nitrogen in the environment. The final report for the California Nitrogen Assessment was completed in 2015. The California Nitrogen Assessment executive summary states, "*Nitrogen, in various reactive forms, is indispensable to the productivity of California agriculture. And yet, only about half the nitrogen applied ends up where we intend; the balance leaks, polluting our air and water, with detrimental effects on our environment and human health.*" … "*California can lead the way for the world in seeking a better balance between managing nitrogen as an essential agricultural input and minimizing its negative impacts on communities and the environment."* The information from the California Nitrogen Assessment will be used to help agricultural producers continue to improve methods of fertilizer and manure application to maximize nitrogen use efficiency and minimize environmental impacts, such as contamination of groundwater and emissions of NH3 to the atmosphere.

As part of the efforts to reduce the environmental impacts of nitrogen usage on California farms, California regulations have been adopted that apply to the use of manure and fertilizers in agricultural operations. These regulations have been adopted by the State Water Resources Control Board, which enforces state and federal water quality protection laws and regulates agricultural sources to ensure compliance with these laws. The State Water Resources Control Board consists of Regional Water Quality Control Boards (Regional Boards) that develop objectives and plans to protect the beneficial uses of water, recognizing local differences in climate, topography, geology and hydrology. The Central Valley Regional Water Quality Control Board adopts water quality regulations in California's Central Valley and monitors compliance with these regulations. The Central Valley Regional Water Quality Control Board has recently adopted regulations that will reduce the amount of nitrogen that agricultural facilities can apply to cropland and will result in decreased emissions of NH3.

These regulations include the Waste Discharge Requirements General Order for Existing Milk Cow Dairies (Dairy General Order, adopted in 2007 and revised and re-issued in 2013), the Waste Discharge Requirements General Order for Confined Bovine Feeding Operations (Bovine Feedlot General Order, adopted in 2017), and the Waste Discharge Requirements General Order for Confined Poultry Operations (Poultry General Order, adopted in 2016). The Dairy General Order applies to dairy operations, the Bovine Feedlot General Order applies to facilities other than dairies in which cattle are confined, and the Poultry General Order applies to poultry operations of a certain size. In addition to the water quality regulations that apply to confined animal feeding operations, the Central Valley Regional Water Quality Control Board ensures compliance with water quality objectives on commercial agricultural land that is not covered under another order, including managing nitrogen applied to cropland, through the Irrigated Lands Regulatory Program. The Irrigated Lands Regulatory Program initially began as a means to prevent agricultural runoff from polluting surface waters, subsequently groundwater regulations were added to the program in 2012. Agricultural operations throughout the Central Valley are subject to waste discharge requirements that protect both surface water and groundwater.

Agricultural operations that are not subject to a general order or the Irrigated Lands Regulatory Program are generally regulated via individual orders that ensure compliance with the same requirements. The requirements of these orders for Confined Animal Feeding Operations include:

- A Nutrient Management Plan (NMP), prepared by a certified professional crop advisor or equivalent, designed to control nutrient losses for protection of surface water and groundwater and ensure compliance with the requirements for the whole farm nitrogen balance;
- A Waste Management Plan (WMP), prepared by a licensed engineer, designed to ensure that waste generated at the facility is properly managed and stored until such time that it can be applied to cropland;
- Environmental sampling and monitoring of soil, manure, water and plant tissue for compliance;
- Periodic site inspections, record-keeping, and reporting; and
- Additional groundwater monitoring to assess ongoing water quality protection

The requirements for agricultural operations that are subject to the Irrigated Lands Regulatory Program include preparation of a Nitrogen Management Plan that accounts for all of the nitrogen applied to fields through irrigation water and fertilizers and the nitrogen removed by crops.

The purpose of these regulations is to minimize the impacts that these operations have on the quality of surface and groundwater, including prevention of runoff and leaching of nitrogen compounds to the environment. This has generally required reductions in the amount of nitrogen that has traditionally been applied to agricultural lands, which also results in reductions in emissions of NH3 to the atmosphere.

The Nutrient Management Plan and Nitrogen Management Plan are designed to assure that the amount of nitrogen applied to agricultural lands is in reasonable balance with the needs of crops grown at the farm. Nitrogen from manure at confined animal feeding operations in excess of crop needs must be exported off the farm to where it can be used by other crops. Manure used on the farm is required to be stored safely until it is used and then only applied to agricultural fields in the amounts needed and during periods when it is required by crops growth. Over-application or mistimed application of nitrogen fertilizers can result in unnecessary losses of nitrogen to the environment, both as seepage below the root zone (in the form of nitrate or other nitrogen compounds)[105] or as air emissions of NH3 gas and oxides of nitrogen.

In accordance with the recommendations contained in the University of California document Managing Dairy Manure in the Central Valley of California (2005), the Central Valley Regional Water Quality Control Board Dairy General Order, Bovine Feedlot

[105]See Chang, A., Harter, T., Letey, J., Meyer, D., Meyer, R.D., Campbell-Mathews, M., Mitloehner, F., Pettygrove, S., Robinson, P., Zhang, R., (2005) Managing Dairy Manure in the Central Valley of California. Publication 9004, Division of Agriculture and Natural Resources. University of California. Available at: http://groundwater.ucdavis.edu/files/136450.pdf

General Order, and Poultry General Order generally prohibit the amount of total nitrogen applied to agricultural fields from exceeding 1.4 times the amount that will be removed from the field in the harvested portion of the crop. To comply with these more stringent targets for nitrogen application, many confined animal feeding operations have had to greatly increase the precision of their manure and fertilizer applications, while also reducing the overall amount of nitrogen applied to their crops.[106] For instance, on a group of San Joaquin Valley dairy farms, it was estimated that prior to adoption of the General Order in 2007, the total inputs of nitrogen were 1,070 lb-N/acre-year, the amount of nitrogen removed by crops was 500 lb-N/acre-year, and potential losses of nitrogen to groundwater alone ranged from 370 to 570 lb-N/acre-year.[107] Based on this study, it can be estimated that, as a result of full implementation of the Dairy General Order, the total amount of nitrogen applied to cropland at dairies will be reduced by approximately 35% compared to conditions prior to the Dairy General Order, with resulting reductions in NH3 emissions. Similar reductions in the amount of nitrogen applied to agricultural fields associated with other cattle facilities and poultry facilities and resulting NH3 emissions can reasonably be expected as a result of implementation of the Bovine Feedlot General Order and Poultry General Order.

Adjusting the timing of nitrogen application to increase nitrogen uptake by crops is also expected to reduce emissions of NH3 by reducing the amount of nitrogen that is available for volatilization. Some research already suggests that lower emissions of reactive nitrogen will occur by timing applications of nitrogen to better coincide with the needs for crop growth. The California Nitrogen Assessment suggests that synchronizing fertilizer application with crop demand will reduce emissions of NH3 and N2O to the atmosphere, while also reducing the flow of nitrates to groundwater. The California Air Resource Board report Assessment of Nitrous Oxide Emissions in California's Dairy Systems[108] states regarding synchronizing nitrogen application with crop demand, "Once the N requirement for each crop stage is known, the N applications can be adjusted accordingly. This strategy should lead to improved N use efficiency and likely lower N2O emissions."

Agricultural operations in California are continuing to improve management practices to improve nitrogen utilization and minimize nitrate leaching in crop production. These practices will also result in reduced emissions of reactive nitrogen. Researchers at UC Cooperative Extension have been studying the nitrogen use efficiency for various crop types and have begun identifying the point at which the application of additional nitrogen no longer significantly increases crop quality and yields. This will allow growers to apply fertilizer with more precision to reduce the amount of nitrogen left in the soil. Because of the recent efforts in California to address the environmental impacts of reactive nitrogen,

[106] Harter, T., Menke, J., (2005) Cow Numbers and Water Quality – Is There a Magic Limit? – A Groundwater Perspective. Revised Manuscript from Proceedings, National Alfalfa Symposium, December 13-15, 2004, San Diego, CA. UC Cooperative Extension, University of California, Davis 95616. Available at: http://groundwater.ucdavis.edu/files/136450.pdf
[107] Harter, T., Menke, J., (2005)
[108] Horwath, W. R., Burger, M., Pettygrove, S. (November 2013) Assessment of Nitrous Oxide Emissions in California's Dairy Systems. Final Report to the California Air Resources Board, Contract No. 09-325. Available at: https://www.arb.ca.gov/research/apr/past/09-325.pdf

the overall efficiency of nitrogen usage at California farms is expected to increase and emissions of reactive nitrogen, including NH3, are expected to decrease significantly.

RULE 4565 (BIOSOLIDS, ANIMAL MANURE, AND POULTRY LITTER OPERATIONS)

Discussion

District Rule 4565 was adopted on March 15, 2007. The primary purpose of this rule is to limit emissions of volatile organic compounds (VOC) from operations involving the management of biosolids, animal manure, or poultry litter. District Rule 4565 applies to operations that landfill, land apply, compost, or co-compost these materials. Composting facilities subject to Rule 4565 fall into one of three categories based on the wet tons of compostable materials received at the facility for processing annually (annual throughput): facilities with throughputs less than 20,000 tons per year; those with at least 20,000 tons, but less than 100,000 tons per year; and those with throughputs of at least 100,000 tons per year. In addition to limiting VOC emissions, the measures required by District Rule 4565 have also been demonstrated to limit ammonia (NH3) emissions from these operations.

NH3 emissions from biosolids, animal manure, and poultry litter result from the microbial decomposition of nitrogenous compounds in these materials and the subsequent volatilization of the ammonia that is produced. In general, the class one mitigation measures required by District Rule 4565 consist of management practices that facilitate stabilization of the nitrogen during co-composting operations and reduce volatilization of gaseous pollutants. The class two mitigation measures required by District Rule 4565 apply to the largest composting operations and involve use of a control device, typically a biofilter.

Descriptions of some of the mitigation measures required by District Rule 4565 and the ways in which these measures reduce NH3 emissions are provided below:

- <u>Injection, land incorporation, or covering biosolids, animal manure, and poultry litter that is land applied into fields</u>: Injection, incorporation, or covering biosolids, animal manure, or poultry litter applied to cropland reduces volatilization of gaseous pollutants by minimizing the amount of time that these materials are exposed to the atmosphere. Once the waste has been injected into the soil, incorporated into the soil, or covered with soil, NH3 and VOCs are absorbed onto soil particles, providing the opportunity for soil microbes to oxidize these compounds into nitrates, carbon dioxide, and water.[109]

- <u>Covering Active and Curing Compost Piles with a waterproof covering, six inches of finished compost, or six inches of soil</u>: Covering composting piles with a waterproof covering reduces exposure of the VOCs and NH3 to the atmosphere

[109] US EPA Emissions Standards Division, Office of Air Quality Planning and Standards (August 2001). Emissions from Animal Feeding Operations (Draft). EPA Contract 68-D6-0011. Available at: https://www3.epa.gov/ttn/chief/ap42/ch09/draft/draftanimalfeed.pdf

thereby reducing volatilization of these compounds. Covering the compost piles with finished compost or soil reduces emissions in the same manner as a biofilter; microorganisms in the finished compost or soil facilitate conversion of VOCs and NH3 to carbon dioxide, nitrogen, water, and biomass before the compounds are emitted to the atmosphere. Source testing of engineered covers for compost piles (e.g. Gore covers) have demonstrated control efficiencies of greater than 90% for VOC and 60% for NH3 (without venting to a biofilter). Additionally, the report prepared by CalRecycle for the San Joaquin Valley Air Pollution Control District Technology Advancement Program (TAP) project: Greenwaste Compost Site Emissions Reductions from Solar-Powered Aeration and Biofilter Layer (5/14/2013)[110] demonstrated control efficiencies greater than 90% for VOC and between 53% to greater than 83% for NH3 for compost piles covered with one foot of finished compost.

- Aerated Static Piles (ASPs) or In-Vessel Composting Vented to a Biofilter: For large composting facilities with annual throughputs of at least 100,000 tons per year, District Rule 4565 requires implementation of at least one Class Two Mitigation Measure. The Class two mitigation measures require active composting or curing of compost to be conducted using aerated static piles or in-vessel composting vented to a control device with a minimum control efficiency of 80% for VOC, or implementation of an equivalent mitigation measure. As previously mentioned, because of practical and economic considerations, large composting operations that must control emissions and/or odors almost universally use biofilters as control devices. Although District Rule 4565 only specifies a VOC control efficiency of 80%, when biofilters are designed and operated to achieve the required VOC control efficiency, they also result in a similar control efficiency for NH3 emissions.

  The SCAQMD Final Staff Report for Proposed Amended Rule 1133.1 – Chipping and Grinding Activities and Proposed Rule 1133.3 – Emission Reductions from Greenwaste Composting Operations (July 2011)[111] states "*Based on the information collected on existing biofilter composting applications, overall control efficiencies of about 80 to 90 percent for VOC and 70 to over 90 percent for ammonia have been achieved*." and also states "*Based on source tests data from existing cocomposting operations (Inland Empire Regional Composting Facilities and City of Los Angeles Sanitation Bureau), properly designed and maintained biofilters have demonstrated over 90 percent destruction efficiencies for both VOC and ammonia emissions.*"

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[110] CalRecycle – Principal Study Author Robert Horowitz (5/14/2013) Greenwaste Compost Site Emissions Reductions from Solar-Powered Aeration and Biofilter Layer. Funded by and prepared for the San Joaquin Valley Air Pollution Control District Technology Advancement Program (TAP). Available at: http://www.valleyair.org/Grant_Programs/TAP/documents/C-15636-ACP/C-15636_ACP_FinalReport.pdf

[111] South Coast AQMD (July 2011) Final Staff Report for Proposed Amended Rule 1133.1 – Chipping and Grinding Activities and Proposed Rule 1133.3 – Emission Reductions from Greenwaste Composting Operations. Available at: http://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2011/2011-jul8-037.pdf?sfvrsn=2

Source Category

Composting facilities subject to Rule 4565 fall into one of three categories based on the wet tons of compostable materials received at the facility for processing annually (annual throughput): facilities with throughputs less than 20,000 tons per year; those with at least 20,000 tons, but less than 100,000 tons per year; and those with throughputs of at least 100,000 tons per year or greater.

Emissions from Composting Facilities Subject to District Rule 4565:

The composting mitigation measures included in District Rule 4565 focus on the following three primary emission sources at composting facilities: (a) receiving/mixing areas, (b) active-phase compost piles, and (c) curing-phase compost piles.

The following discussion describes the assumptions used to estimate the District Rule 4565 NH3 control efficiencies for the different emissions sources identified for composting operations.

<u>NH3 Emissions from the Receiving and Mixing (Scraping) Areas</u>

At a composting facility, compostable material is delivered, unloaded, mixed, and then transferred to the active composting area, which may consist of piles, windrows, or engineered systems. During these initial steps, the NH3 is emitted from the compostable material. NH3 from these operations can be reduced by properly maintaining the receiving and mixing areas by scraping or sweeping on a regular basis (Class One Mitigation Measure #1). This will also reduce the total surface area of these materials that is exposed to the atmosphere from which emissions occur. It is assumed that the magnitude of the emissions flux during this process equals the emissions flux during the active phase of composting, but the total time of emissions from these processes is limited.

The following assumptions will be used to estimate the District Rule 4565 NH3 control efficiency receiving and mixing compostable materials:

- The NH3 emissions factor for compostable materials in the receiving and mixing area is 0.00046 lb-NH3/ton-hr. This is a conservative value based on flux chamber source testing results from uncontrolled active-phase co-composting as determined by Schmidt and Card (2002, 2004).[112]

- Total NH3 emissions are based on the annual throughput of the facility, assuming that all compostable material (throughput) sits in the scraping area for two hours per day, six days per week, and 50 weeks per year, for a total of 600 hours per year.

[112] Card, T. and Schmidt, C. (2002). *Emissions Evaluation of Aerated Static Pile Composting of Anaerobically Digested Biosolids at the Davenport Composting Facility* (Draft Report). Prepared for Southern California Alliance of Publicly Owned Treatment Works and updated in 2004.

NH3 Emissions from Active-Phase and Curing Phase Composting

The NH3 emission factor for co-composting operations is based on South Coast Air Quality Management District (SCAQMD) Rule 1133.2 (Emission Reductions from Co-composting Operations), which is 2.93 lb-NH3/ton. This emission factor accounts for the NH3 emissions during both the active phase and curing phase of composting. For purposes of estimating the NH3 control efficiency for District Rule 4565, it is assumed that the percentage of the co-composting NH3 emission factor attributed to the active and curing phases of composting is the same as the percentage of the VOC emission factor attributed to each of these phases. The District document "Compost VOC Emission Factors" (September 15, 2010)[113] indicates that 90% of composting VOC emissions are attributed to the active phase and 10% to the curing phase. The same ratio of 90% of emissions from the active phase of composting and 10% for the curing phase of composting will be assumed for NH3 emissions.

District Rule 4565 Control Measure Efficiencies:

The estimated NH3 control efficiencies for the District Rule 4565 mitigation measures are summarized in the table below.

Overall NH3 Control Efficiencies for Rule 4565 Mitigation Measures	
Class 1 Measures	**Overall Control Efficiency**
Scrape to ≤ 1"	10%
Cover Active Piles ≥ 6"	60%
Cover Curing Piles ≥ 6"	60%
Class 2 Measures	**Overall Control Efficiency**
Active-Phase ASPs to ≥ 80% control device	26%
Active-Phase in-vessel to ≥ 80% control device	80%
Curing-Phase ASPs to ≥ 80% control device	26%
Curing-Phase in-vessel to ≥ 80% control device	80%
ASPs + Compost Cover	**Control Efficiency**
Active-Phase ASPs to ≥ 80% control device + Compost Cover	70%
Curing-Phase ASPs to ≥ 80% control device + Compost Cover	70%

[113] San Joaquin Valley Air Pollution Control District [SJVAPCD]. (September 15, 2010). Compost VOC Emission Factors. Fresno, CA: San Joaquin Valley Air Pollution Control District. Available at: http://www.valleyair.org/busind/pto/emission_factors/Criteria/Criteria/Composting/Compost%20EF.pdf

As mentioned above, the CalRecycle report prepared for San Joaquin Valley Air Pollution Control District TAP Project: Greenwaste Compost Site Emissions Reductions from Solar-Powered Aeration and Biofilter Layer (5/14/2013) demonstrated control efficiencies of between 53% to greater than 83% for NH3 for compost piles covered with one foot of finished compost. Based on data from a study prepared for the San Joaquin Valleywide Air Pollution Study Agency (2009),[114] the District previously estimated that a finished compost cover would achieve a VOC reduction of 56% compared to an uncontrolled pile; therefore, the compost cover is conservatively estimated to have a control efficiency of 60% for NH3. The NH3 control efficiency for aerated static piles with a compost cover is estimated to be 70% also based the CalRecycle project report. The remaining NH3 control efficiencies for scraping and the Class 2 measures are assumed to be the same as the VOC control efficiencies that were used in the original 2006 rulemaking process for Rule 4565 and as used by SCAQMD for SCAQMD Rule 1133.2 (Emission Reductions from Co-composting Operations).

NH3 Control Efficiencies for Class One Mitigation Measures

- Scraping: A conservative NH3 control efficiency of 10% is assumed for scraping and maintaining the areas for receiving and mixing compostable materials

- Compost Cover: The District estimated 60% control efficiency for NH3 during the active phase of composting based on an emissions profile derived from SJVAPSA (2011). Given the use of the same type of compost cover and the nature of the emissions, the District also estimates 60% control efficiency for compost cover during the curing phase.

NH3 Control Efficiencies for Class two Mitigation Measures

- Active phase and curing-phase aerated static pile systems (ASPs) venting to a control device with 80% control efficiency: The District conservatively assumes a 33% capture efficiency for an uncovered aerated static pile system. Applying an 80% control to the captured emissions results in an overall NH3 control efficiency of 26%, as shown below:

  Overall Control: 0.33 x 0.8 x 100 = 26%

- In-vessel active and curing-phase composting venting to a control device with 80% control efficiency: Engineered in-vessel composting systems are expected to capture 100% of the emissions from the composting operation. Applying 80% control efficiency to 100% capture results in an overall NH3 control efficiency of 80%.

[114] San Joaquin Valleywide Air Pollution Study Agency [SJVAPSA]. (2011). *Comparison of Mitigation Measures for Reduction of Emissions Resulting from Greenwaste Composting*. Fresno, CA: San Joaquin Valleywide Air Pollution Study Agency. Retrieved from website: http://www.valleyair.org/busind/pto/emission_factors/Criteria/Criteria/Composting/FINAL-COMPOST-STUDY-REPORT.pdf (Final Report)

- ASPs plus compost cover: Alternatively, a facility may choose to use ASPs with a compost cover that is vented to a control device with 80% control efficiency. As mentioned above, based on the study report prepared for the San Joaquin valley Technology Advancement Program (2013), the control efficiency of an ASP with a compost cover is 70%.

The minimum expected overall District Rule 4565 NH3 control efficiencies for land application of biosolids, animal manure, or poultry litter and co-composting facilities with throughputs of less than 20,000 tons per year, 20,000 tons but less than 100,000 tons per year, and 100,000 tons per year or more are summarized in the tables below.

Estimated Overall NH3 Control Efficiencies for Rule 4565 Mitigation Measures for Land Application of Biosolids, Animal Manure, and Poultry Litter	
Rule 4565 Requirements for Land Application	**Estimated Overall NH3 Control Efficiency**
Direct injection within three hours of receipt at the facility **Or** Land incorporation within three hours of receipt at the facility; Materials received after 6 pm must be land incorporated by noon of the following calendar day **Or** Cover the biosolids, animal manure, or poultry litter with waterproof cover, six inches of finished compost, or six inches of soil within three hours of receipt at the facility	50%*

* *Injection, incorporation, and covering biosolids, animal manure, or poultry litter are expected to have a similar control efficiency as covering compost piles; however, an NH3 control efficiency of 50% rather than 60% has been used for a more conservative estimate*

Estimated Minimum Overall NH3 Control Efficiencies for Rule 4565 Mitigation Measures for Co-Composting Facilities of Different Sizes		
Facility Throughput (wet tons/yr)	**Rule 4565 Requirements**	**Estimated Overall NH3 Control Efficiency**
< 20,000 wet tons per year	At least three Class One mitigation measures or At least two Class One mitigation measures in addition to one Class Two mitigation measure for active composting	10%
20,000 but < 100,000 wet tons per year	At least four Class One mitigation measures or At least three Class One mitigation measures in addition to one Class Two mitigation measure for active composting	10%
≥ 100,000 wet tons per year	At least four Class One mitigation measures in addition to one Class Two mitigation measure for active composting or	31%

	At least two Class One mitigation measures, in addition to one Class Two mitigation measure for active composting and one Class Two mitigation measure for curing composting	

How does District Rule 4565 compare with federal and state rules and regulations?

For the 2018 PM2.5 Plan, the District identified federal, state, and local air quality regulations and compared them to analogous District rules to identify potential emission reductions opportunities. Any potential opportunities identified were then analyzed to determine if they are technologically and economically feasible to require in Valley.

Federal requirements such as NSPS, NESHAP, MACT, CTGs, and ACTs and state regulations are not applicable to this source category.

How does District Rule 4565 compare to rules in other air districts?

District staff compared District Rule 4565 with the rules for biosolids, animal manure, and poultry litter operations from other California air districts. District staff only located one other air district rule that applied to similar sources, which was SCAQMD Rule 1133.2. No other air district rules that applied to similar sources were found.

SCAQMD

- SCAQMD Rule 1133.2 - Emission Reductions from Co-Composting Operations *(Adopted January 10, 2003)*

SCAQMD Rule 1133.2 was adopted in 2003, and the rule has not since been amended. This rule applies to new and existing co-composting operations in the SCAQMD. The table below summarizes the significant differences between SCAQMD Rule 1133.2 and SJVAPCD Rule 4565. For purposes of this analysis, the NH3 control efficiency for the requirements of District Rule 4565 are assumed to be the same as the VOC control efficiency for these requirements since the same measures generally result in similar control efficiencies for both VOC and NH3 from these operations.

For example, covering compost with a waterproof covering, finished compost, or soil is assumed to have a control efficiency of 60% for both VOCs and NH3. As discussed above, a properly designed and operated biofilter can achieve a control efficiency of greater than 90% for NH3 and VOC emissions, but will conservatively assumed to have a control efficiency of 80% for purposes of this analysis.

It should also be noted that in practice, the facilities that are actually subject to SCAQMD Rule 1133.2 will have much larger throughputs than 1,000 ton per year throughput threshold given in the rule. SCAQMD Rule 1133.2 includes the following exemptions for existing co-composting operations with a design capacity of less than 35,000 tons of throughput per year containing no more than 20 percent biosolids by volume and new and existing municipal facilities using aeration and processing less than 5,000 tons of biosolids or manure per year. Many operations in the SCAQMD have found it to be economical to transport these materials to other jurisdictions for processing. An example of this is the Synagro South Kern Compost Manufacturing Facility, which is a newer facility located in the Valley and processes biosolids transported from SCAQMD.

Because some mitigation measures are only cost-effective for larger facilities, District staff developed the concept of Class One and Class Two mitigation measures. Class One mitigation measures are cost effective options for all facilities, regardless of size. These measures are management practices found to be best practices for all composting operations. Class Two mitigation measures are the technology options and achieve reductions greater than Class One mitigation measures; however, they were determined to not be cost effective for facilities with throughputs of less than 100,000 wet tons per year. District Rule 4565 requires reductions from two additional categories (landfilling and land applying) when compared to SCAQMD Rule 1133.2. For the third category, composting, District staff determined it is not cost effective to require in-vessel (enclosed) composting.

Category	SCAQMD Rule 1133.2	SJVUAPCD Rule 4565	Reason
Facilities Other Than Co-Composting (Landfilling, Land Applying)	Rule does not apply to these operations	Management practice requirements	Knowledge of control options has increased since Rule 1133.2 adoption and staff believes that cost effective methods of controlling VOC and NH3 emissions from these facilities exist.
Co-Composting Threshold for Applicability	Facilities with at least 1,000 tpy throughput	Facilities that handle 100 tpy or more of biosolids, animal manure, or poultry litter	Staff believes that there are reasonable options that are not exceedingly costly for facilities with throughputs of ≥100 tpy that would not impose an undue burden on operators.
Composting Control Requirements	In-vessel composting with 70% control efficiency for VOC and NH3 for existing facilities and 80% control efficiency for VOC and NH3 for new facilities	Control efficiency of 10%-80% for VOC (and NH3) depending on type of operation and facility throughput	Management practices (mitigation measures) are effective, reasonable, and have been achieved in practice for smaller facilities. In-vessel composting is not cost-effective for smaller or medium facilities and there are no known, unsubsidized facilities in the SCAQMD that would comply with such rule requirements.

Additional Emission Reduction Opportunities

Beyond the review of current regulation and rule requirements, the District performed an extensive review of the feasibility of expanding applicability or removal of exemptions for this source category, technologies and measures that have been implemented in practice in other regions, and potential new technologies and measures that may be feasible for implementation in the near future. Based on this review, District staff did not find any additional measures currently available or that will be available prior to the 2025 attainment deadline date that could improve the effectivity of this rule.

Evaluation Findings

While BACM and MSM requirements do not apply to ammonia since it is not a significant precursor to PM2.5 formation in the Valley, District staff concludes that District Rule 4565 and major sources of ammonia in the Valley satisfy BACM and MSM requirements for ammonia emissions from biosolids, animal manure, and poultry litter operations.

RULE 4566 (ORGANIC MATERIAL COMPOSTING OPERATIONS)

Discussion

District Rule 4566 (Organic Material Composting Operations) was adopted on August 18, 2011, to limit VOC emissions from composting facilities whose feedstock consists of greenwaste and/or food waste. The rule applies to new and existing organic material composting and stockpiling facilities in which the feedstock consists of green material (e.g. vegetative waste material generated from gardening, agriculture, or landscaping activities, etc.) and/or food waste with <100 ton/yr biosolids or manure. In addition to limiting VOC emissions, the measures required by District Rule 4566 have also been demonstrated to limit ammonia (NH3) emissions from these operations. However, it should be noted that the NH3 emissions from greenwaste and food waste composting are generally low, with the NH3 measurements often resulting in values below the detection limit of measurement methods.[115]

NH3 emissions from green material and food waste result from the microbial decomposition of nitrogenous compounds in these materials and the subsequent volatilization of the ammonia that is produced. The mitigation measures required by District Rule 4566 include management practices that facilitate stabilization of the nitrogen during composting operations and reduce volatilization of gaseous pollutants. Examples of the mitigation measures required by District Rule 4566 that reduce VOC and NH3 emissions include use of a watering system to maintain sufficient moisture in the compost and covering windrows with at least six inches of finished compost. In addition, District Rule 4566 requires the largest green material and food waste composting facilities to demonstrate VOC reductions of at least 80% during the active phase through use of a control device, such as a biofilter, which would also reduce NH3 emissions.

Additional information on the ways in which the mitigation measures required by District Rule 4566 reduce NH3 emissions is provided below:

- Watering Systems: The use of watering systems to maintain sufficient moisture in the compost windrows reduces NH3 emissions from the compost because NH3 is very soluble in water; therefore, when sufficient moisture is maintained in the compost windrows much of the NH3 will dissolve in the water, thereby reducing emissions. Regarding the effect that moisture has on the NH3 emission rate from

[115] For example the CalRecycle Report: Emissions Testing of Volatile Organic Compounds from Greenwaste Composting at the Modesto Compost Facility in the San Joaquin Valley (Revised May 2008). Publication #442-07-009. Available at: https://www2.calrecycle.ca.gov/Publications/Download/860 states, "*Note that ammonia was not detected by the laboratory to a method detection limit of 0.02 ppmv*"

manure, the draft EPA report Emissions from Animal Feeding Operations (August 2001) [116] states "*Because of its high solubility in water, the loss of ammonia to the atmosphere will be more rapid when drying of manure occurs.*" This is also true for NH3 emissions from composting because NH3 emissions from composting and manure are the result of the same basic processes. In addition, because NH3 is a weak base, when NH3 dissolves in water, a portion of the NH3 will be converted to ammonium (NH4+), which unlike NH3, is not volatile. This results in a greater amount of ammonical nitrogen (NH3/NH4+) remaining in the windrows and becoming stabilized in the compost rather than volatilizing to the air. The additional moisture from the watering system will also reduce the air-filled porosity at the surface of compost windrows, thereby reducing the diffusion of NH3 to the surface of the windrow and subsequent volatilization. Information from the report Gaseous Emissions from Management of Solid Waste: a Systematic Review (2015) indicates that the measured NH3 emissions from solid waste under moist conditions was 33% lower than under dry conditions. [117] In addition, the final report Comparison of Mitigation Measures for Reduction of Emissions from Greenwaste Composting (2011)[118] prepared for the San Joaquin Valleywide Air Pollution Study Agency (SJVAPSA) demonstrated a significant VOC control efficiency (at least 20%) for irrigation of compost windrows. Although, the NH3 emissions from composting of greenwaste are much lower than VOC emissions, based on the available information, the control efficiency for NH3 is expected to be similar.

- Covering Compost Piles with Finished Compost: Covering the compost piles with finished compost or soil reduces emissions in the same manner as a biofilter; microorganisms in the finished compost or soil facilitate conversion of VOCs and NH3 to carbon dioxide, nitrogen, water, and biomass before the compounds are emitted to the atmosphere. The report prepared by CalRecycle for the San Joaquin Valley Air Pollution Control District Technology Advancement Program (TAP) project: Greenwaste Compost Site Emissions Reductions from Solar-Powered Aeration and Biofilter Layer (5/14/2013) [119] demonstrated control efficiencies greater than 90% for VOC and between 53% to greater than 83% for NH3 for compost piles covered with one foot of finished compost.

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[116] US EPA Emissions Standards Division, Office of Air Quality Planning and Standards (August 2001). Emissions from Animal Feeding Operations (Draft). EPA Contract 68-D6-0011. Available at: https://www3.epa.gov/ttn/chief/ap42/ch09/draft/draftanimalfeed.pdf

[117] Pardo, G., Moral, R., Aguilera, E., Del Prado, A. (2015) Gaseous Emissions from Management of Solid Waste: a Systematic Review; (2015); Global Change Biology; 21, 2015, 1313-1327. https://doi.org/10.1111/gcb.12806

[118] Büyüksönmez, F. (2011) Comparison of Mitigation Measures for Reduction of Emissions from Greenwaste Composting. Funded by and prepared for t the San Joaquin Valleywide Air Pollution Study Agency (SJVAPSA). 09-01-CCOS. Available at: http://valleyair.org/busind/pto/emission_factors/Criteria/Criteria/Composting/FINAL-COMPOST-STUDY-REPORT.pdf

[119] CalRecycle – Principal Study Author Robert Horowitz (5/14/2013) Greenwaste Compost Site Emissions Reductions from Solar-Powered Aeration and Biofilter Layer. Funded by and prepared for the San Joaquin Valley Air Pollution Control District Technology Advancement Program (TAP). Available at: http://www.valleyair.org/Grant_Programs/TAP/documents/C-15636-ACP/C-15636_ACP_FinalReport.pdf

- District and EPA Approved Mitigation Measures that Demonstrates at Least 80% VOC Reduction by Weight: For the largest green material and food waste composting facilities with annual throughputs of at least 750,000 wet tons per year, District Rule 4566 requires implementation of a mitigation measure that demonstrates a VOC control efficiency of 80% during the active phase of composting. There are currently no greenwaste or food waste composting operations of this size in the San Joaquin Valley that would be subject to District Rule 4566. However, because of practical and economic considerations, large composting operations that must control emissions and/or odors almost universally use biofilters as control devices. Although District Rule 4566 only specifies a VOC control efficiency, when biofilters are designed and operated to achieve the required VOC control efficiency, they also result in a similar control efficiency for NH3 emissions. The SCAQMD Final Staff Report for Proposed Amended Rule 1133.1 – Chipping and Grinding Activities and Proposed Rule 1133.3 – Emission Reductions from Greenwaste Composting Operations (July 2011)[120] states "*Based on the information collected on existing biofilter composting applications, overall control efficiencies of about 80 to 90 percent for VOC and 70 to over 90 percent for ammonia have been achieved*." and also states "*Based on source tests data from existing cocomposting operations (Inland Empire Regional Composting Facilities and City of Los Angeles Sanitation Bureau), properly designed and maintained biofilters have demonstrated over 90 percent destruction efficiencies for both VOC and ammonia emissions.*"

Composting facilities subject to District Rule 4566 fall into one of three categories based on the wet tons of compostable materials processed at the facility annually (annual throughput): facilities with throughputs less than 200,000 wet tons per year; those with throughputs of at least 200,000 wet tons per year, but less than 750,000 wet tons per year; and those with throughputs of at least 750,000 wet tons per year.

The mitigation measures required by District Rule 4566 focus on the active phase of composting because the active phase of composting is the part of the composting process in which the compost feedstock is rapidly decomposing resulting in the highest emissions. The District document "Compost VOC Emission Factors" (September 15, 2010)[121] indicates that 90% of composting VOC emissions are attributed to the active phase and 10% to the curing phase. Based on the information from the source test reports, the NH3 emissions measurements resulted in a similar profile with vast majority of NH3 emissions occurring during the active phase of composting. Therefore, the same ratio of 90% of emissions from the active phase of composting and 10% for the curing phase of composting will be assumed for NH3 emissions.

[120] South Coast AQMD (July 2011) Final Staff Report for Proposed Amended Rule 1133.1 – Chipping and Grinding Activities and Proposed Rule 1133.3 – Emission Reductions from Greenwaste Composting Operations. Available at: http://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2011/2011-jul8-037.pdf?sfvrsn=2

[121] San Joaquin Valley Air Pollution Control District [SJVAPCD]. (September 15, 2010). Compost VOC Emission Factors. Fresno, CA: San Joaquin Valley Air Pollution Control District. Available at: http://www.valleyair.org/busind/pto/emission_factors/Criteria/Criteria/Composting/Compost%20EF.pdf

Source Category

As discussed above, the mitigation measures required by SJVAPCD Rule 4566 will reduce both VOC and NH3 from these operations. As previously mentioned, the report Gaseous Emissions from Management of Solid Waste: a Systematic Review (2015) indicates that the measured NH3 emissions from solid waste under moist conditions was 33% lower than under dry conditions; however, for purposes of this analysis, the NH3 control efficiency achieved for implementation of the watering system mitigation measure will be conservatively assumed to be equivalent to the minimum required VOC control efficiency of 19%. The NH3 control efficiency for implementation of the Finished Compost Cover Mitigation measure will also be assumed to be equivalent to the minimum required VOC control efficiency of 60% for facilities with an annual throughput of 200,000 wet tons to less than 750,000 wet tons. As discussed above, this control efficiency is supported by the information in the report prepared by CalRecycle for the San Joaquin Valley Air Pollution Control District Technology Advancement Program (TAP) project: Greenwaste Compost Site Emissions Reductions from Solar-Powered Aeration and Biofilter Layer (5/14/2013). For the largest greenwaste and food waste composting operations with annual throughputs 750,000 wet tons or more, it is expected that they will use a biofilter as a control device, which will achieve a minimum NH3 control efficiency of 75%.

District Rule 4566 Control Measure Efficiencies:
The minimum expected overall District Rule 4566 NH3 control efficiencies for green material and food waste composting facilities with throughputs of less than 200,000 wet tons per year, 200,000 wet tons but less than 750,000 wet tons per year, and 750,000 wet tons per year or more are summarized in the tables below.

Estimated Minimum Overall NH3 Control Efficiencies for Rule 4566 Mitigation Measures for Greenwaste and Food Waste Composting Facilities of Different Sizes		
Facility Throughput (wet tons/yr)	**Rule 4566 Requirements**	**Estimated Overall NH3 Control Efficiency***
< 200,000 wet tons per year	For windrow composting only, implement at least three turns during the active phase and one of the mitigation measures for the Watering Systems in Table 1. or Implement an APCO and EPA approved alternative mitigation measure that demonstrates at least a 19% reduction, by weight, in VOC emissions.	17.1%
200,000 but < 750,000 wet tons per year	For windrow composting only, implement all of the following: - At least three turns during the active phase; - One of the mitigation measures for the Watering Systems in Table 1; and - The Finished Compost Cover mitigation measure. or	54%

	Implement an APCO and EPA approved alternative mitigation measure that demonstrates at least 60% reduction, by weight, in VOC emissions.	
≥ 750,000 wet tons per year	An operator of a composting operation with a total throughput of greater than or equal to 750,000 wet tons per year of organic material shall implement an APCO and EPA approved mitigation measure that demonstrates at least 80% reduction, by weight, in VOC emissions for organic material during the active phase.	67.5%**

* *These mitigation measures are only required during the active phase of composting. Based on the emission measurements at composting operations, it is assumed that 90% of the total VOC and NH3 emissions occur during the active phase of composting; therefore, the overall control efficiency will be the minimum required control efficiency multiplied by 90%.*

** *NH3 control efficiency conservatively assumed to be 75% for active phase of composting*

How does District Rule 4566 compare with federal and state rules and regulations?

Federal requirements such as NSPS, NESHAP, MACT, CTGs, and ACTs and state regulations are not applicable to this source category.

How does District Rule 4566 compare to rules in other air districts?

District staff compared District Rule 4566 with the rules for greenwaste and foodwaste composting operations from other California air districts. The results of the analysis are discussed below. District staff only located one other air district rule that applied to similar sources: SCAQMD Rule 1133.3. No rules that apply to organic materials composting operations were located for Bay Area Air Quality Management District, Sacramento Metropolitan Air Quality Management District, or Ventura County Air Pollution Control District.

SCAQMD

- SCAQMD Rule 1133.3 - Emission Reductions from Greenwaste Composting Operations *(Adopted July 8, 2011)*

The purpose of SCAQMD Rule 1133.3 is to reduce emissions of VOCs and NH3 from greenwaste and food waste composting operations. The table below compares the significant similarities and differences between SJVAPCD Rule 4566 and SCAQMD Rule 1133.3. For purposes of this analysis, the ammonia control efficiencies achieved by the requirements of SJVAPCD Rule 4566 are assumed to be the same as the VOC control efficiencies since the same control measures will reduce both VOC and NH3 from these operations. Greenwaste/food waste composting produces about 16% of the ammonia emissions on a per ton basis compared to co-composting.[122]

As shown in the table below, based on discussions with SCAQMD permitting and rule development staff, SCAQMD does not have any greenwaste composting production facilities subject to the 80% ammonia reduction requirement of Rule 1133.3.

[122] SCAQMD Rule 1133.3, baseline NH_3 emissions from greenwaste/foodwaste composting = 0.46 lb-NH3/ton-throughput. SCAQMD Rule 1133.2, baseline NH_3 emissions from co-composting = 2.93 lb-NH3/ton-throughput.

In previous conversations and correspondence with District staff, SCAQMD staff has indicated that the SCAQMD does not currently permit open windrow composting operations or require them to comply with SCAQMD Rule 1133.2.[123] This would be the majority of composting operations, particularly in the District where there is more land available.

Based on the information from SCAQMD staff, there is currently only one facility (Inland Empire Regional Composting Facility) in the SCAQMD that performs full-scale co-composting inside a building that vents the exhaust through a biofilter.[124]

Rancho Las Virgenes Composting Facility may also have enclosed composting vented to a biofilter. However, this facility appears to be exempt from SCAQMD Rule 1133.2 since it is an existing composting operation (composting began in 1993 or 1994) with less than 10,000 tons per year of throughput. Controls were likely added to prevent nuisance odors from affecting the surrounding area. Moreover the throughput for Las Virgenes has been nil since 2012 according to SCAQMD's annual emissions reporting.

It must also be noted that many operations in the SCAQMD have found it to be economical to transport materials to other jurisdictions, such as the SJVAPCD, for composting. An example of this is the Synagro South Kern Compost Manufacturing Facility, which is a facility located in the San Joaquin Valley and processes biosolids transported from SCAQMD.

Because SCAQMD has no existing production greenwaste composting facilities that are subject to the 80% ammonia control requirement of Rule 1133.3, and the new facilities are permitted under experimental research exemptions, then Rule 1133.3 should not be used to establish BACM or MSM as 80% for that category/throughput level of greenwaste composting.

[123] Email correspondence between SJVAPCD Air Quality Engineer, Brian Clerico, and SCAQMD Planning and Rules Manager, Tracy Goss, June 16, 2015.
[124] Email correspondence between SJVAPCD Air Quality Engineer, Brian Clerico, and SCAQMD Air Quality Specialist, Jong Hoon Lee, June 25, 2015.

Rule Section	SCAQMD Rule 1133.3	District Rule 4566	Explanation of Differences
Applicability	New and existing greenwaste and food waste composting operations.	New and existing organic material composting and stockpiling facilities. (Organic material is defined as green material, food material, or mixtures of the two, with <100 ton/yr biosolids or manure.)	SCAQMD Rule 1133.3 limits food waste stockpiling time (48 hr), whereas District Rule 4566 limits organic material stockpiling time (3 or 10 days, depending on throughput).
Exemptions	Applicability/exemptions based on facility type, not throughput.	Applicability/exemptions based on facility type, not throughput.	The same types of facilities are exempt in both rules: facilities subject to a co-composting rule (SCAQMD Rule 1133.2 or District Rule 4565), nursery, household, recreational, and community composting facilities. District Rule 4566 also exempts agricultural facilities which are subject to District Rules 4204, 4550, or 4570.
Composting Control Requirements	• ≤5,000 ton/yr food waste or ≤20% manure (watering and finished compost cover or ≥20% control for NH3) • >5,000 ton/yr food waste, (emission control device with ≥80% control for NH3)	• <200,000 ton/yr organic material (watering system or ≥19% control for NH3) • ≥200,000 and <750,000 ton/yr organic material (watering system and finished compost cover or ≥60% control for NH3) • ≥750,000 ton/yr organic material (emission control device with ≥80% control for NH3)	The throughput/control levels in Rule 4566 are based on cost effectiveness and socioeconomic studies conducted by the District as part its Final Staff Report for the Revised Proposed New Rule 4566 (Appendices C and D, August 18, 2011). Rule 4566 requires the same management practices and control requirements as Rule 1133.3; however, the throughput levels at which the stricter control requirements in Rule 4566 become triggered are much higher than in Rule 1133.3. Thus, on paper, Rule 1133.3 appears to be more stringent than Rule 4566. However, SCAQMD does not have any greenwaste composting facilities (that are not under an experimental research permit) subject to the 80% control requirements of Rule 1133.3.

Additional Emission Reduction Opportunities

District Rule 4566 (Organic Material Composting) is the most stringent rule in the nation for controlling emissions from composting operations; additional controls are infeasible.

Evaluation Findings

While BACM and MSM requirements do not apply to ammonia since it is not a significant precursor to PM2.5 formation in the Valley, District staff concludes that District Rule 4566 meets BACM and MSM requirements for ammonia emissions from greenwaste and foodwaste composting operations. The District evaluated the feasibility of additional ammonia emissions reductions and did not identify any additional feasible measures. The District has taken every regulatory action feasible to reduce emissions from this source and continues to seek additional methods to reduce emissions through innovative strategies, such as the support of research and technology demonstrations.

C.25 Emission Inventory Code (EIC) Table

Control Measure	Emission Inventory Codes
Rule 4103 (Open Burning)	670-660-0262-9842; 670-660-0262-9862; 670-660-0262-9874; 670-660-0262-9884; 670-660-0262-9888; 670-660-0262-9892; 670-662-0262-9878; 670-668-0200-9858; 670-668-0200-9872; 670-668-0200-9886; 670-995-0240-9848
Rule 4104 (Reduction of Animal Matter)	420-995-6004-0000
Rule 4106 (Prescribed Burns)	670-666-0200-0000; 670-670-0200-0000
Rule 4203 (Particulate Matter Emissions from the Incineration of Combustible Refuse)	010-005-0243-0000
Rule 4204 (Cotton Gins)	420-418-6028-0000; 420-420-6028-0000
Rule 4301 (Fuel Burning Equipment)	
Rule 4307 (Boilers, Steam Generators and Process Heaters 2 – 5 MMBtu/hr)	010-005-0110-0000; 010-005-0124-0000; 010-005-0130-0000; 010-005-0300-0000; 010-005-1220-0000; 020-005-0110-0000; 030-005-0110-0000; 030-005-0124-0000; 030-005-0130-0000; 030-005-1220-0000; 030-005-1530-0000; 030-010-0110-0000; 030-010-0130-0000; 030-010-1220-0000; 030-010-1600-0000; 030-015-0110-0000; 030-015-0130-0000; 040-005-0110-0000; 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; 050-005-0320-0000; 050-005-1100-0000; 050-005-1220-0000; 050-005-1510-0000; 050-005-1520-0000; 050-005-3220-0000; 050-010-0110-0000; 050-010-0120-0000; 050-010-0320-0000; 050-010-1220-0000; 050-010-1500-0000; 052-005-0110-0000; 052-005-0124-0000; 052-005-1220-0000; 052-010-0110-0000; 052-010-0120-0000; 052-010-1224-0000; 060-005-0110-0000; 060-005-0122-0000; 060-005-0124-0000; 060-005-0130-0000; 060-005-0142-0000; 060-005-0144-0000; 060-005-0320-0000; 060-005-1220-0000; 060-005-1510-0000; 060-005-1520-0000; 060-010-0100-0000; 060-010-0110-0000; 060-010-0120-0000; 060-010-0142-0000 The EICs are the same for Rules 4306/4320, 4307, and 4308; the three rules share a combined emission inventory. Baseline emissions from the 2008 and 2009 rule amendments of these rules were used to determine the percentage of emissions for each rule. Those respective percentages are applied to the combined inventory to get the individual emission inventories.
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. Baseline emissions from the 2008 and 2009 rule amendments of these rules were used to determine the percentage of emissions for each rule. Those respective percentages are applied to the combined inventory to get the individual emission inventories. See Rule 4307 for the EICs.
Rule 4309 (Dryers)	430-422-7078-0000; 430-424-7006-0000; 430-995-7000-0000; 499-995-0000-0000; 499-995-5630-0000

Control Measure	Emission Inventory Codes
Rule 4311 (Flares)	110-132-0130-0000; 110-132-0146-0000; 120-132-0136-0000; 130-132-0110-0000; 130-132-0130-0000; 130-132-0136-0000; 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
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 4320 (AERO for Boilers, Steam Generators, and Process Heaters >5 MMBtu/hr)	The EICs are the same for Rules 4306/4320, 4307, and 4308; the three rules share a combined emission inventory. Baseline emissions from the 2008 and 2009 rule amendments of these rules were used to determine the percentage of emissions for each rule. Those respective percentages are applied to the combined inventory to get the individual emission inventories. 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; 020-005-0218-0000; 020-005-0230-0000; 030-005-0214-0000; 050-005-0214-0000; 050-005-0240-0000; 050-005-0254-0000; 052-005-0240-0000; 060-005-0240-0000; 060-005-0264-0000
Rule 4354 (Glass Melting Furnaces)	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 4641 (Cutback, Slow Cure, and Emulsified Asphalt, Paving and Maintenance Operations)	540-560-0400-0000; 540-562-0400-0000; 540-564-0400-0000; 540-566-0400-0000
Rule 4692 (Commercial Charbroiling)	690-680-6000-0000
Rule 4702 (Internal Combustion Engines)	010-040-0110-0000; 010-040-1200-0000; 020-040-0110-0000; 020-040-1200-0000; 030-040-0110-0000; 030-040-0124-0000; 030-040-1200-0000; 030-040-1210-0000; 040-040-0110-0000; 050-040-0012-0000; 050-040-0110-0000; 050-040-0124-0000; 050-040-1200-0000; 052-040-0110-0000; 052-040-1200-0000; 052-042-0110-0000; 052-042-1200-0000; 052-042-1200-0010; 052-042-1200-0011; 060-040-0110-0000; 060-040-0124-0000; 060-040-0142-0000; 060-040-0146-0000; 060-040-1100-0000; 060-040-1200-0000; 060-040-1210-0000; 060-995-1220-0000; 099-040-1200-0000
Rule 4703 (Stationary Gas Turbines)	010-045-0110-0000; 010-045-1200-0000; 020-045-0110-0000; 030-045-0110-0000; 040-045-0134-0000; 050-045-1200-0000; 060-045-0110-0000; 060-045-1200-0000
Rule 4802 (Sulfuric Acid Mist)	410-400-2058-0000
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 Residential Central Furnace)	610-606-0110-0000
Rule 8011 (General Requirements)	There is no specific emissions inventory associated with Rule 8011.

Control Measure	Emission Inventory Codes
Rule 8021 (Construction, Demolition, Excavation, Extraction, and Other Earthmoving Activities)	630-622-5400-0000; 630-624-5400-0000; 630-626-5400-0000; 630-628-5400-0000; 630-634-5400-0000
Rule 8031 (Bulk Materials)	430-436-7006-0000; 430-436-7078-0000; 430-995-7064-0000
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 Traffic)	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 (Ag Sources)	645-646-5400-0000
Lawn Care Equipment	860-902-1100-4065; 860-902-1100-4094; 860-902-1100-4095; 860-902-1100-4102; 860-902-1100-4103; 860-902-1100-4112; 860-902-1100-4113; 860-902-1100-4124; 860-902-1100-4125; 860-902-1100-5672; 860-902-1100-5673; 860-902-1100-5684; 860-902-1100-5685; 860-902-1100-5692; 860-902-1100-5693; 860-902-1100-5704; 860-902-1100-5705; 860-902-1100-5724; 860-902-1100-5725; 860-902-1100-7604; 860-902-1100-7605; 860-902-1100-7614; 860-902-1100-7615; 860-902-1100-8104; 860-902-1100-8105; 860-902-1100-8112; 860-902-1100-8113; 860-902-1100-8344; 860-902-1100-8345; 860-902-1100-8352; 860-902-1100-8353; 860-902-1100-8364; 860-902-1100-8365; 860-902-1100-8372; 860-902-1100-8373; 860-902-1100-8384; 860-902-1100-8385; 860-902-1100-9074; 860-902-1100-9075; 860-902-1100-9542; 860-902-1100-9543; 860-902-1100-9554; 860-902-1100-9555; 860-902-1100-9834; 860-902-1100-9835; 860-903-1100-1394; 860-903-1100-1395; 860-903-1100-1404; 860-903-1100-1405; 860-903-1100-4084; 860-903-1100-4085; 860-903-1100-5744; 860-903-1100-5745; 860-903-1100-5754; 860-903-1100-5755; 860-903-1210-1190; 860-903-1210-1200; 860-903-1210-1210; 860-903-1210-1220; 860-903-1210-1230; 860-903-1210-1240; 860-903-1210-1250; 860-903-1210-1350; 860-903-1210-1380; 860-903-1210-4050; 860-903-1210-4070; 860-903-1210-4130; 860-903-1210-4140; 860-903-1210-4150; 860-903-1210-5710; 860-903-1210-5730; 860-903-1210-8390; 860-903-1210-8400; 860-903-1210-8410