APPENDIX B

Emission Reduction Analysis
For Proposed Amendments to Rules 4401, 4409, 4455, 4623, & 4624

June 15, 2023

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EMISSIONS REDUCTION ANALYSIS
FOR PROPOSED RULES 4401, 4409, 4455, 4623, and 4624

I.   SUMMARY

The San Joaquin Valley Air Pollution Control District (District) committed to amend Rules 4401, 4409, 4455, 4623, and 4624 as part of the Best Available Retrofit Control Technology (BARCT) analysis pursuant to Assembly Bill (AB) 617 requirements, in addition to commitments from the *2022 Plan for the 2015 8-Hour Ozone Standard* (*2022 Ozone Plan*). This appendix details the calculations and assumptions used to estimate the volatile organic compound (VOC) emission reductions associated with the proposed amendments.

Table B-1 presents a summary of the total emission reductions in tons per day (tpd) of VOC for each rule and for the entire project. Section II includes a detailed emission reductions analysis.

Table B-1 Total VOC Reductions at 500 ppm

Rule	VOC Reduction at 500 ppmv (tpd)
4401	0.073
4409	0.293
4455	0.00037
4623	0.210
4624	0.021
Total	**0.597**

II.   EMISSION REDUCTION ANALYSIS

This section of the report outlines the procedures used to calculate the current emissions and the estimated emission reductions associated with the proposed amendments to Rules 4401, 4409, 4455, 4623, and 4624.

This analysis applied Equation 1 to the components affected by Rules 4401, 4409, 4455, 4623, and 4624 to calculate potential emissions from each facility at the proposed limit(s). The District used Equation 1 to calculate the percent reduction for each pollutant from affected categories by calculating the percent difference between the current potential emissions and potential emissions at the proposed amended limit(s).

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$$\%_{Reduced} = \frac{(\sum E_{Current} - \sum E_{Proposed})}{\sum E_{Current}} \qquad \text{(Equation 1)}$$

Where:

$\%_{Reduced}$ = percent reduction;
$E_{Current}$ = current potential emissions; and
$E_{Proposed}$ = the potential emissions at proposed limits.

The District calculated the emission reductions by multiplying the current potential emissions in Table B-2 by the calculated percent reductions determined with Equation 2, as follows:

$$ER = EI \times \%_{Reduced} \qquad \text{(Equation 2)}$$

Where:

ER = emission reduction;
EI = emission inventory; and
$\%_{Reduced}$ = calculated percent reductions, per Equation 2.

A.   Affected Components

Table B-2 Summary of VOC Emission Reductions @ 500 ppmv

Rules	Number of Components	Current VOC Emissions tons/day	Emissions at Proposed 500ppm tons/day	Estimated VOC Reductions tons/day	Estimated VOC Reductions Percentage
4401	893,392	0.34	0.27	0.07	21.5%
4409	1,511,035	1.50	1.21	0.29	19.5%
4455	1708	0.0029	0.0025	0.0004	12.8%
4623	179,052	0.73	0.53	0.21	28.7%
4624	40,001	0.13	0.11	0.02	15.6%
Total	**2,625,188**	**2.70**	**2.12**	**0.59**	**21.9%**

*estimated reductions are rounded integers

The components identified in the emissions reduction are sourced from the California Air Resources Board's (CARB) 2007 Oil and Gas Industry Survey Results[1], and District information from Operator Management Plans.

B.   Emission Reduction Calculation Methodology

An emissions factor is a representative value that attempts to relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant. These factors express the weight of pollutant divided by a unit weight,

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[1] State of California, California Environmental Protection Agency, Air Resources Board. "2007 Oil and Gas Industry Survey Results. Retrieved from: https://ww2.arb.ca.gov/sites/default/files/2020-04/finalreport_1.pdf

volume, distance, or duration of the activity emitting the pollutant (e.g., pounds of VOC emitted per hour). Such factors facilitate estimation of emissions from various sources of air pollution. In most cases, these factors are averages of all available data of acceptable quality, and are representative of long-term averages for all facilities in the source category (i.e., a population average).

The calculation of VOC emissions for the current rules and the emission reductions are derived from the methodology established in Section 5-7 and Appendix A of EPA's Protocol for Equipment Leak Emission Estimates.[2] EPA's protocol contains equations for calculating average leak rates for each type of component and type of service. Additionally, EPA's protocol document outlines a method for predicting the leak rate after the implementation of Leak Detection and Repair (LDAR) programs. Equation 3 determines the Average Leak Rate of a component based on the ppmv limit and type of service (gas or liquid).

$$ALR = \left(LR \frac{kg}{hr} * LkFrac \right) + ELTC \qquad \text{(Equation 3)}$$

Where,
ALR: Average Leak Rate
LR: leak rate in kilograms per hour
LkFrac: Leak Fraction
ELTC: Equipment Leak Type Constant

$$EM = ALR * Components \qquad \text{(Equation 4)}$$

Where,
EM: Emissions kg/hr
ALR: Average Leak Rate
Components: number of components in service

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[2] EPA. Protocol for Equipment Leak Emission Estimates. EPA 453/R-95-017. November 1995. Retrieved from https://www3.epa.gov/ttnchie1/efdocs/equiplks.pdf

**Table B-3 Equations for Calculating Initial Average Leak Rate –
From EPA 453/R-95-017, Table 5-7**

Components	Gas	
Average Leak Rate Rules at 10,000 ppmv For Gas Services		
Components	**Gas**	
Valves	0.093 * (LkFrac) + 0.0000250	
Pumps/Compressors	0.074 * (LkFrac) + 0.0003500	
Others	0.089 * (LkFrac) + 0.0001200	
Connectors	0.026 * (LkFrac) + 0.0000100	
Flanges	0.082 * (LkFrac) + 0.0000057	
Average Leak Rate for Rules at 2,000 ppmv for Gas Services		
Components	**Gas**	
Valves	0.083 * (LkFrac) + 0.0000140	
Pumps/Compressors	0.052 * (LkFrac) + 0.0002300	
Others	0.066 * (LkFrac) + 0.0000450	
Connectors	0.020 * (LkFrac) + 0.0000085	
Flanges	0.059 * (LkFrac) + 0.0000026	
Average Leak Rate at 1,000 ppmv for Gas Services and Liquid Services		
Components	**Gas**	**Liquid**
Valves	0.076 * (LkFrac) + 0.0000110	0.069 * (LkFrac) + 0.0000120
Pumps/Compressors	0.052 * (LkFrac) + 0.0002300	0.079 * (LkFrac) + 0.0001500
Others	0.061 * (LkFrac) + 0.0000310	0.058 * (LkFrac) + 0.0000440
Connectors	0.018 * (LkFrac) + 0.0000080	0.021 * (LkFrac) + 0.0000083
Flanges	0.051 * (LkFrac) + 0.0000180	0.046 * (LkFrac) + 0.0000012

**Table B-4 Equations for Calculating Average Leak Rate at Proposed 500 ppmv for
Gas and Liquid Components**

Components	Gas	Liquid
Valves	0.070 * (LkFrac) + 0.0000091	0.059 * (LkFrac) + 0.0000094
Pumps/Compressors	0.027 * (LkFrac) + 0.0001100	0.071 * (LkFrac) + 0.0000790
Others	0.055 * (LkFrac) + 0.0000180	0.053 * (LkFrac) + 0.0000340
Connectors	0.016 * (LkFrac) + 0.0000077	0.016 * (LkFrac) + 0.0000077
Flanges	0.043 * (LkFrac) + 0.0000011	0.037 * (LkFrac) + 0.00000094

LkFrac = Leak Fraction

Using Equation 3, the Average Leak Rate can be determined for each component type
and service type. The emissions for components can be determined using equation 4

to multiply the Average Leak Rate by the total amount of components. To determine the VOC Baseline Emissions, total organic carbon (TOC) emissions from the components are calculated using the average TOC emission factors from Table 2-4 of EPA 453/R-95-017. District calculations indicate that 19% of all TOC is VOC. Table B-5 presents the emissions reduction comparison at current leak limits to the proposed 500 ppmv leak limit. Table B-6 shows the calculated VOC emission reductions.

Table B-5 Emissions Comparison at Current Leak Limits and 500 ppmv

Rule	Total Components	Current Emissions		Emissions @ 500 ppmv	
		kg/hr[3]	tons/year[4]	kg/hr[5]	tons/year[6]
4401*	893,392	12.9	125	10.14	97.9
4409	1,511,035	56.9	549	45.77	442.0
4455	1,708	0.11	1.05	0.10	1.05
4623*	179,052	27.7	267	20.04	190.4
4624	40,001	5.09	49	4.29	41.5
Totals	2,625,188	102.6	991	80.35	773

*Majority component emissions reduction were calculated from 1,000 ppmv to 500 ppmv as most components were subject to COGR, prior to the rule amendment.

Table B-6 Emissions Reduction of VOC

Rule	Reductions tons/year VOC[7]	Reductions tons/day VOC[8]
4401	26.8	0.073
4409	107.0	0.293
4455	0.135	0.00037
4623	76.8	0.210
4624	7.7	0.021
Total	218.4	0.597

*Reductions are presented as rounded integers

C.   SIP Credit from Proposed Rules

Table B-5 includes the potential current emissions for permitted sources in the San Joaquin Valley. However, in order to determine the emission reductions for the State Implementation Plan, the District normalized the emission reductions to the planning inventory. Table B-7 summarizes the emission inventory codes (EICs) associated with the District's LDAR rules.

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[3] Current Emissions = (ALR) x (% of VOC in TOC) *results will be in kg/hr
[4] Current Emissions (tpy) = (emissions in kg/hr) x (lbs/kg ratio) x (yr/hr ratio) x (tons/lbs ratio)
[5] Emissions at 500 ppmv = (ALR) x (% of VOC in TOC) *results will be in kg/hr
[6] Emissions at 500 ppmv (tpy) = (emissions in kg/hr) x (lbs/kg ratio) x (yr/hr ratio) x (tons/lbs ratio)
[7] Emissions Reduction (tpy)= (Current emissions) – (Emissions at 500 ppmv)
[8] Emissions Reduction (tpd) = (tpy)/365

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Table B-7 List of EICs for Rules 4401, 4409, 4455, 4624, and 4624

Rules	EICs	EIC Summary
4401 & 4409	310-302-0110-0000; 310-302-1600-0000; 310-304-1600-0000; 310-302-0100-0000 310-304-0100-0000; 310-316-0110-0000; 310-306-1600-0000; 310-308-1600-0000 310-308-0110-0000; 310-303-0100-0000; 310-304-0110-0000; 330-302-1600-0000 310-310-0110-0000; 310-310-1600-0000; 310-316-1600-0000; 310-306-0110-0000 310-310-1600-0000; 330-304-1600-0000; 310-352-0100-0000; 310-356-0110-0000 310-303-1600-0000; 310-316-0100-0000; 330-306-1600-0000	Fugitive losses from oil and gas production
4455	320-302-0010-0000; 320-304-0010-0000; 320-306-0010-0000 320-316-0010-0000; 320-308-0010-0000	Fugitive losses from petroleum refining
4623	310-326-1600-0000; 310-328-1600-0000; 310-995-1600-0000; 310-322-1600-0000 310-326-2000-0000; 310-328-1420-0000; 310-328-3174-0000; 320-322-1420-0000 320-324-1600-0000; 320-328-0410-0000; 320-326-1610-0000; 330-322-1600-0000 330-326-1120-0000; 330-328-1120-0000; 330-330-1120-0000; 320-326-1000-0000 320-326-1214-0000; 320-326-1410-0000; 310-324-1100-0000; 310-326-2026-0000 310-328-1610-0000; 310-328-3220-0000; 320-322-1600-0000; 320-326-0410-0000 320-328-1120-0000; 330-321-1000-0000; 330-322-1610-0000; 330-326-1130-0000 330-328-1130-0000; 330-330-1130-0000; 320-326-1610-0000; 320-328-1000-0000 320-328-1110-0000; 310-324-1600-0000; 310-326-3220-0000; 310-328-2000-0000 310-328-4998-0000; 320-322-1610-0000; 320-326-1000-0000; 320-328-1130-0000 330-321-1410-0000; 330-324-1000-0000; 330-326-1210-0000; 330-328-1222-0000 330-330-1420-0000; 320-328-1214-0000; 320-328-1410-0000; 320-328-1610-0000 310-325-0100-0000; 310-326-4998-0000; 310-328-2026-0000; 310-995-1600-0000 320-324-1000-0000; 320-326-1110-0000; 320-328-1530-0000; 330-322-1000-0000 330-324-1224-0000; 330-326-1410-0000; 330-328-1410-0000; 430-328-7006-0000 330-326-1110-0000; 330-326-1420-0000; 330-328-1000-0000; 310-326-1000-0000 310-328-1000-0000; 310-328-3000-0000; 320-322-1000-0000; 320-324-1100-0000 320-326-1130-0000; 320-328-3202-0000; 330-322-1214-0000; 330-324-1420-0000 330-326-1600-0000; 330-328-1420-0000; 330-328-1110-0000; 330-328-1600-0000 330-328-1610-0000; 310-326-1420-0000; 310-328-1110-0000; 310-328-3033-0000 320-322-1130-0000; 320-324-1110-0000; 320-326-1530-0000; 320-328-3220-0000 330-322-1224-0000; 330-324-1600-0000; 330-326-1610-0000; 330-328-1600-0000 430-328-7006-0000; 310-326-1610-0000; 310-328-1130-0000; 310-328-3156-0000 320-322-1214-0000; 320-324-1224-0000; 320-326-3202-0000; 320-322-1000-0000 330-322-1420-0000; 330-326-1000-0000; 330-326-3000-0000; 330-328-1610-0000	Fugitive losses from organic liquid storage tanks
4624	330-302-0010-0000; 330-995-0110-0000; 330-304-0010-0000; 330-308-0110-0000 330-384-1130-0000; 330-995-0010-0000; 330-316-0010-0000; 330-318-0110-0000 330-316-0010-0000; 330-995-1100-0000; 330-316-1600-0000; 330-332-1000-0000 330-338-0010-0000; 330-382-1130-0000	Fugitive losses from petroleum marketing

The District calculated the emission reductions by multiplying the current potential emissions defined in Table B-2 by the calculated percent reductions determined with Equation 2, as follows:

$$ER = EI \times \%_{Reduced}$$ (Equation 2)

Where:
    ER = emission reduction;
    EI = emission inventory; and
    $\%_{Reduced}$ = calculated percent reductions, per Equation 2.

Table B-8 includes the total VOC emissions from the EICs listed above.

Table B-8 Annual Average 2024 VOC Emission Inventory from Rules 4401, 4409, 4455, 4623, and 4624 (tpd)[9]

Rules	Tons/day
4401 and 4409	1.015
4455	0.147
4623	2.398
4624	1.166
Total	**4.725**

To determine the emission reductions achieved for SIP purposes, the District multiplied the percent reductions from Table B-2 by the planning inventory in Table B-8.
Table **B-9** presents the results of this calculation.

Table B-9 Emission Reductions from Proposed Amendments in Implementation Years (tons per day)

Rules	% of Emissions Reduced at 500 ppmv	Tons/day of VOC reduced from CEPAM Data @ 500ppmv
4401 and 4409	19.9%	0.20
4455	12.8%	0.02
4623	28.7%	0.69
4624	15.6%	0.18
Total		**1.09**

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[9] CEPAM Ozone SIP 2019 v1.04

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