

APPENDIX B

**Emission Reduction Analysis
For Revised Proposed Amendments to Rule 4905**

December 23, 2014

SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT

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SAN JOAQUIN VALLEY UNIFIED AIR POLLUTION CONTROL DISTRICT

EMISSION REDUCTION ANALYSIS FOR REVISED PROPOSED AMENDMENTS TO RULE 4905

I. SUMMARY

Rule 4905 reduces emissions of oxides of nitrogen (NOx) by establishing NOx emissions for natural gas-fired, fan-type residential central furnaces (residential units) sold in the San Joaquin Valley (Valley) with a rated heat input capacity of less than 175,000 British thermal units per hour (Btu/hr), and for combination heating and cooling units, a rated cooling capacity less than 65,000 Btu/hr.

Proposed amendments to Rule 4905 would lower the NOx emission limit for residential units and add NOx emission limits for units installed in commercial buildings (commercial units) and units installed in manufactured homes. The NOx emission limit for residential units would be lowered and the applicability expanded to include commercial units and units installed in manufactured homes. Because Rule 4905 is a point-of-sale rule, emission reductions would be achieved gradually as older units are replaced over the 20 year turnover period from 2017 through 2036.

The District's *2008 PM2.5 Plan*, *2012 PM2.5 Plan*, and *2013 Plan for the Revoked 1-hour Ozone Standard* included commitments to amend Rule 4905, but did not specify an emission reduction commitment for this proposed rule amendment; therefore, there is no comparison between a plan emission reduction commitment and the proposed rule emissions reduction. The baseline NOx emissions and estimated NOx emission reductions for residential and commercial units are summarized in Table B-1 below.

Table B-1 Summary of Emission Reductions from Natural Gas-Fired, Fan-Type Central Furnaces (2036)

Furnace Category	2036 Baseline NOx Emissions Inventory (tons per day)	NOx Emission Reduction Upon Full Turnover in 2036 (tons per day)	Percent Reduction from Projected 2036 Baseline (%)
Residential	3.24	1.61	50.0
Commercial	0.92	0.48	52.2
TOTAL	4.16	2.10	50.5

II. BACKGROUND

Rule 4905 applies to any person who supplies, sells, offers for sale, installs, or solicits the installation of natural gas-fired, fan-type residential central furnaces with a rated heat input capacity less than 175,000 Btu/hr, and for combination heating and cooling units, a rated cooling capacity less than 65,000 Btu/hr. Units in the applicable size range are used in nearly all residences with access to natural gas and the majority of

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commercial buildings. As demonstrated in this appendix, the 2036 total baseline NO_x emission inventory for units affected by proposed rule amendments is 4.16 tons per day (tpd).

The proposed rule amendments would lower the NO_x emission limit for residential units to 14 ng/J; establish a NO_x emission limit of 14 ng/J for commercial units; and require units installed in manufactured homes to comply with a NO_x emission limit of 40 ng/J and lower the NO_x emission limit for these units to 14 ng/J in 2018. The compliance dates for proposed amendments are as follows:

- February 1, 2015 for units installed in manufactured homes,
- April 1, 2015 for condensing residential and commercial units,
- October 1, 2015 for non-condensing residential and commercial units, and
- October 1, 2018 for the lower NO_x emission limit for units installed in manufactured homes.

Manufacturers, distributors, and retailers would also be allowed a 300-day sell-through period for units manufactured prior to the applicable compliance date. Manufacturers that are unable to commercialize new units, or that are unable to respond to the increase in demand in time for the compliance dates would have the option of paying a per unit emission fee for each noncompliant unit sold in the San Joaquin Valley for up to 36 months after the applicable compliance date. As a point-of-sale rule, Rule 4905 emission reductions would be achieved through attrition as older units are replaced over the 20 year expected life-span of the units during the period from 2017 through the end of 2036.

Units installed in manufactured homes already achieve the proposed 40 ng/J NO_x limit without requiring any modifications¹, but residential and commercial units would require new control technologies to achieve the proposed NO_x emission limit of 14 ng/J. Based on technology assessment results (see Staff Report), new units will likely exceed the proposed NO_x emission limit of 14 ng/J; however, the District would claim SIP credit for emission reductions gained from implementing the proposed NO_x emission limit of 14 ng/J. The following section details the assumptions made for the emission reduction analysis, and describes the research and equations used to estimate the total NO_x emission reductions upon full turnover at the end of 2036.

III. EMISSION REDUCTION ANALYSIS

A. Assumptions for the Emission Reduction Analysis

District staff gathered data from District staff reports, plans, and emissions inventory methodologies; South Coast Air Quality Management District (SCAQMD) Staff Reports

¹ SCAQMD. (2009, November 6). *Final Staff Report with Socioeconomic Impact Assessment*. Retrieved 9/16/14 from <http://www3.aqmd.gov/hb/2009/November/091130a.htm>.

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from the November 2009 and September 2014 amendments to Rule 1111^{2,3}; the California Air Resources Board (CARB) emissions inventory⁴; a *2009 California Residential Appliance Saturation Study* prepared by KEMA, Inc. for the California Energy Commission (CEC) (KEMA Study)⁵; and Pacific Gas and Electric's (PG&E) *Commercial Building Survey Report*.⁶

For the purposes of this Emission Reduction Analysis, the following assumptions were made:

1. The emissions inventory category (EIC) used for residential units (610-606-0110-0000) includes emissions from units installed in manufactured homes.
2. The KEMA Study accurately estimates the percent of California population residing in mobile homes and the percent of mobile homes using natural gas heating. These estimates serve as accurate surrogates for the use of natural gas in manufactured homes in the Valley.

According to the KEMA Study, 3.5% of the California population lives in mobile homes, and 70% of mobile homes use gas heating. Assuming that all gas heating in mobile homes is attributed to furnaces, the fraction of emissions from combustion of natural gas for residential space heating in manufactured homes is $(0.035) \times (0.7) = 0.0245$ (or 2.45%).

3. No additional emission reductions would be achieved from units installed in manufactured homes because these units are already meeting the 40 ng/J NO_x emission limit. Although reductions would be achieved from units installed in manufactured homes after the proposed 14 ng/J NO_x emission limit is implemented in 2018, these reductions are expected to be insignificant in comparison to total reductions; therefore, the District did not analyze these reductions and would not claim SIP credit for them.
4. The EIC used for commercial units (060-020-0110-0000) was calculated by assuming that commercial natural gas combustion for space heating is attributable to small boilers; however, the PG&E *Commercial Building Survey*

² SCAQMD. (2009, November 6). *Final Staff Report with Socioeconomic Impact Assessment*. Retrieved 9/16/14 from <http://www3.aqmd.gov/hb/2009/November/091130a.htm>.

³ SCAQMD. (2014, September 5). *Governing Board Agenda Item, September 5, 2014: Amend Rule 1111 – Reduction of NO_x Emissions from Natural-gas-fired, Fan-type Central Furnaces*. Retrieved 9/9/14 from <http://www.aqmd.gov/docs/default-source/Agendas/Governing-Board/2014/2014-sep5-032.pdf?sfvrsn=2>.

⁴ CEPAM, Norcal, Version 1.04. Retrieved 9/9/14 from <planning inventory not available to public>

⁵ KEMA, Inc. (Prepared for California Energy Commission). (2010, October). *2009 California Residential Appliance Saturation Study*. Retrieved 9/17/13 from <http://www.energy.ca.gov/2010publications/CEC-200-2010-004/CEC-200-2010-004-ES.PDF>.

⁶ Pacific Gas and Electric Company. (1999). *Commercial Building Survey Report*. Retrieved 9/17/13 from http://www.pge.com/includes/docs/pdfs/mybusiness/energysavingsrebates/analyzer/buildingreport/ceus_1999.pdf.

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Report cited in the methodology references gas furnaces as providing the majority of commercial space heating. Because the EIC does not separate space heating device types, an estimate was needed for the portion of commercial natural gas combustion for space heating attributed to gas furnaces.

The PG&E *Commercial Building Survey Report* is assumed to accurately estimate the total capacity of natural gas combustion attributed to space heating from gas furnaces used in commercial buildings in the Valley. The total percent of emissions attributed to gas furnaces was obtained by dividing the total heating capacity of gas furnaces in the Valley by the total heating capacity of all device types in the Valley.

Total percent of heating capacity from gas furnaces in the valley and desert/mountain climate regions:

$$\begin{aligned} &= (\text{total gas furnace capacity} / \text{total heating capacity of all units}) \\ &= (12,494 \text{ MMBtu} / 17,805 \text{ MMBtu}) = 70.2\% \end{aligned}$$

5. Because the ARB emission inventory only projects up to 2035, an estimate was made for NO_x emissions from residential and commercial units in 2036. An estimated increase in emissions based on the average annual increase during the previous five years (2031-2035) was used.
6. The baseline NO_x emission factor (EF) for commercial units is the same as the baseline NO_x EF for residential units because the units are essentially the same; therefore, the baseline NO_x EF for residential and commercial units is assumed to be the current Rule 4905 limit of 40 ng/J.
7. Based on the proposed compliance dates and sell-through periods, the District will claim emission reductions starting in 2017. Non-weatherized units are expected to make up the vast majority of sales in the District because weatherized units are primarily installed in regions with severe weather. The emission reduction calculations in this analysis are conservative because the non-weatherized units are required to comply with the proposed emission limits in January and July of 2016 for condensing and non-condensing units, respectively. The unclaimed reductions from these units in 2016 will easily exceed the reductions that will potentially be claimed early for weatherized units.
8. Based on research conducted for the 2005 adoption of Rule 4905, the average life for applicable units is 20 years.
9. Five percent (5%) of units are replaced every year for 20 years, with full compliance reached at the end of 2036.
10. The proposed emission fee option will not impact expected emission reductions.

B. Baseline NOx Emissions Inventory for Uncontrolled Units in 2036

The baseline emissions inventories for units used in residential and commercial buildings were obtained from CARB's CEPAM Norcal V. 1.04. The Emission Inventory Categories (EIC) for residential and commercial units are 610-606-0110-0000 and 060-020-0110-0000, respectively. For both categories, the emissions in 2036 were estimated using the average growth rate of emissions from the previous five years. The total rule baseline emissions inventory for uncontrolled units in residential buildings was calculated as follows:

$$\begin{aligned}
 \text{Baseline}_{\text{residential total (in 2036)}} &= \text{Baseline residential emissions in 2035} + \\
 &\quad \text{average annual increase in emissions from} \\
 &\quad \text{2031-2035} \\
 &= 3.21 \text{ tpd (in 2035)} + \{[3.21 \text{ tpd (in 2035)} - 3.05 \\
 &\quad \text{tpd (in 2031)}]/5\} \\
 &= 3.24 \text{ tpd (in 2036)}
 \end{aligned}$$

For units used in commercial buildings, the fraction of emissions attributed to furnaces was estimated using the PG&E *Commercial Building Survey Report*. As with residential units, the emissions for 2036 were calculated using average annual emission increase for the previous five years. The rule baseline emissions inventory for uncontrolled units used in commercial buildings was calculated as follows:

$$\begin{aligned}
 \text{Baseline}_{\text{commercial total (in 2036)}} &= \text{Baseline commercial emissions from all} \\
 &\quad \text{devices in 2035} + \text{average annual increase in} \\
 &\quad \text{emissions for previous five years} \\
 &= 1.30 \text{ tpd (in 2035)} + \{[1.30 \text{ tpd (in 2035)} - 1.25 \\
 &\quad \text{tpd (in 2031)}]/5\} \\
 &= 1.31 \text{ tpd (in 2036)}
 \end{aligned}$$

$$\begin{aligned}
 \text{Baseline}_{\text{commercial net}} &= \text{Baseline emissions from furnaces used in} \\
 &\quad \text{commercial buildings} \\
 &= (\% \text{ of heating capacity for gas furnaces in} \\
 &\quad \text{Valley}) \times (\text{Baseline}_{\text{commercial total}}) \\
 &= (70.2\%) \times (1.31 \text{ tpd}) \\
 &= 0.92 \text{ tpd (in 2036)}
 \end{aligned}$$

$$\begin{aligned}
 \text{Baseline}_{\text{total}} &= \text{Baseline}_{\text{residential}} + \text{Baseline}_{\text{commercial}} \\
 &= 3.24 \text{ tpd} + 0.92 \text{ tpd} \\
 &= 4.16 \text{ tpd (in 2036)}
 \end{aligned}$$

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C. Annual Reductions

The number of units purchased each year is projected to rise continually during the turnover period; the District would claim reductions from the replacement of units currently in use. Five percent (5%) of the existing units operating in 2017 would be replaced annually, starting in 2017, with full turnover reached at the end of 2036. The annual reductions were calculated as follows:

$$\begin{aligned} \text{Annual Reductions} &= (\text{emissions from 5\% of units replaced annually,} \\ &\quad \text{starting in 2017}) \times (\text{reduction in NOx EF}) \\ &= (\text{net baseline emissions in 2017}) \times (0.05) \times [1 - \\ &\quad (14 \text{ ng/J} / 40 \text{ ng/J})] \end{aligned}$$

For residential units, the emissions from units installed in manufactured homes were estimated using the KEMA *California Residential Appliance Saturation Study* and removed from the baseline because no additional emission reductions would be claimed as a result of proposed amendments for these units. The net rule baseline emissions inventory for residential units meeting only the current NOx emission limit of 0.093 lb/MMBtu (or 55 ppm), with emissions from manufactured homes removed, was calculated as follows:

$$\begin{aligned} \text{Baseline}_{\text{manufactured homes}} &= (\text{Baseline}_{\text{residential total}}) \times (\% \text{ population in mobile} \\ &\quad \text{homes}) \times (\% \text{ of mobile homes using natural} \\ &\quad \text{gas}) \\ &= 2.54 \text{ tpd (in 2017)} \times (3.5\%) \times (70\%) \\ &= 0.06 \text{ tpd (in 2017)} \end{aligned}$$

$$\begin{aligned} \text{Baseline}_{\text{residential net}} &= \text{Baseline emissions from residential units with} \\ &\quad \text{emissions from manufactured homes removed} \\ &= \text{Baseline}_{\text{residential total}} \text{ (from CARB emission} \\ &\quad \text{inventory)}^7 - \text{Baseline}_{\text{manufactured homes}} \\ &= 2.54 \text{ tpd (in 2017)} - 0.06 \text{ tpd (in 2017)} \\ &= 2.48 \text{ tpd (in 2017)} \end{aligned}$$

The annual reduction in NOx emissions from residential units was calculated as follows:

$$\begin{aligned} \text{Annual Reductions}_{\text{residential}} &= (\text{Baseline}_{\text{residential net}}) \times (5\% \text{ of units replaced} \\ &\quad \text{annually}) \times (\text{reduction in NOx EF}) \\ &= (2.48) \times (0.05) \times [1 - (14/40)] \\ &= 0.081 \text{ tpd} \end{aligned}$$

⁷ CEPAM, Norcal, Version 1.04. Retrieved 9/9/14 from <planning inventory not available to public>

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For commercial units, the net baseline emissions were calculated the same way as they were for 2036 as follows:

$$\begin{aligned} \text{Baseline}_{\text{commercial net}} &= \text{Baseline emissions from furnaces used in} \\ &\quad \text{commercial buildings} \\ &= (\% \text{ of heating capacity attributed to gas} \\ &\quad \text{furnaces in Valley}) \times (\text{Baseline}_{\text{commercial total}}) \\ &= 70.2\% \times 1.07 \text{ tpd (in 2017)} \\ &= 0.75 \text{ tpd (in 2017)} \end{aligned}$$

The annual reduction in NOx emissions from commercial units was calculated as follows:

$$\begin{aligned} \text{Annual Reductions}_{\text{commercial}} &= (\text{Baseline}_{\text{commercial net}}) \times (5\% \text{ of units replaced} \\ &\quad \text{annually}) \times (\text{reduction in NOx EF}) \\ &= (0.75) \times (0.05) \times [1 - (0.0325 / 0.093)] \\ &= 0.024 \text{ tpd} \end{aligned}$$

The annual reduction in NOx emission from all units was calculated as follows:

$$\begin{aligned} \text{Annual Reductions}_{\text{total}} &= (\text{Reductions}_{\text{residential}} + \text{Reductions}_{\text{commercial}}) \\ &= 0.105 \text{ tpd total annual NOx emission} \\ &\quad \text{reductions} \end{aligned}$$

D. Percent Reduction upon Full Turnover of Existing Units at the End of 2036

The percent reduction upon full turnover at the end of 2036 was calculated by dividing the total reductions by the total baseline emission inventory. In this case, the baseline inventory includes manufactured homes. While no reductions are claimed for these units, they are still included in the plan inventory; therefore, the final percent reduced should reflect the percent reduction in emissions from the entire source category. The final percent reduction upon full turnover at the end of 2036 is calculated as follows:

$$\begin{aligned} \text{Final reductions} &= (\text{Total annual reductions}) \times (\text{20 years turnover} \\ &\quad \text{period}) \\ &= 0.105 \text{ tpd/year} \times 20 \text{ years} \\ &= 2.10 \text{ tpd} \end{aligned}$$

$$\begin{aligned} \text{Final Percent Reduction} &= (\text{Final reductions} / \text{Baseline emissions in 2036}) \times \\ &\quad 100\% \\ &= 2.10 \text{ tpd} / 4.16 \text{ tpd} \times 100\% \\ &= 50.5\% \text{ total percent reduction in NOx} \\ &\quad \text{emissions upon full turnover in 2036} \end{aligned}$$

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IV. CONCLUSION

As a point-of-sale rule, the NOx emission reductions from this proposed rule amendment would occur gradually through attrition as older units are replaced between 2017 and 2036. The total NOx emission reduction of 2.10 tpd would occur upon full turnover at the end of 2036. Table B-2 illustrates the cumulative NOx emission reductions over this 20 year period.

Table B-2 NOx Emission Reductions for Five-Year Intervals from 2020-2036 (tpd)

Year	2021	2026	2031	2036
Current Total NOx Emission Inventory	3.47	3.69	3.92	4.16
Total NOx Emission Reductions	0.53	1.05	1.58	2.10
NOx Emission Inventory with Proposed Amendments Implemented	2.94	2.64	2.34	2.06