APPENDIX B

Emission Reduction Analysis
For Proposed Amendments to Rule 4905

November 18, 2014

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EMISSION REDUCTION ANALYSIS FOR PROPOSED AMENDMENTS TO RULE 4905

I. SUMMARY

Rule 4905 reduces emissions of oxides of nitrogen (NOx) by requiring 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 to meet a NOx emission limit of 0.093 pounds per million British thermal unit (lb/MMBtu) (or 55 ppmv).

Proposed amendments 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 from 0.093 lb/MMBtu (or 55 ppmv) to 0.0325 lb/MMBtu (or 20 ppmv). A NOx emission limit of 0.0325 lb/MMBtu (or 20 ppmv) would be added for commercial units, and a NOx limit of 0.093 lb/MMBtu (or 55 ppmv) would be added for units installed in manufactured homes. The NOx emission limit for units installed in manufactured homes would be lowered to 0.0325 lb/MMBtu (or 20 ppmv) in 2018. Because Rule 4905 is a point-of-sale rule, emission reductions would be achieved gradually as older units are replaced over the 20 year implementation period from 2017 through 2036.

The *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 Implementation in 2036 (tons per day)	Percent Reduction from Baseline (%)
Residential	3.24	1.61	50.0
Commercial	0.92	0.49	53.3
TOTAL	4.16	2.12	51.0

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

The proposed rule amendments would lower the NOx emission limit for residential units from 0.093 lb/MMBtu (or 55 ppmv) to 0.0325 lb/MMBtu (or 20 ppmv), add a NOx limit of 0.0325 lb/MMBtu (or 20 ppmv), require units installed in manufactured homes to comply with a NOx emission limit of 0.093 lb/MMBtu (or 55 ppmv), and lower the NOx emission limit for units installed in manufactured homes to 0.0325 lb/MMBtu (or 20 ppmv) in 2018. The proposed amendments would take effect January 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 NOx 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. As a point-of-sale rule, Rule 4905 would not immediately affect stakeholders, and emission reductions would be achieved through attrition as older units are replaced over the 20 year period from 2017 through the end of 2036.

Units installed in manufactured homes are capable of achieving the 0.093 lb/MMBtu (or 55 ppmv) limit without requiring any modifications[1], but residential and commercial units would require new control technologies to achieve the proposed NOx emission limit of 0.0325 lb/MMBtu (or 20 ppmv). Based on technology assessment results (see Staff Report), new units will likely exceed the proposed NOx emission limit of 0.0325 lb/MMBtu (or 20 ppmv); however, the District would claim SIP credit for emission reductions gained from implementing the proposed NOx emission limit of 0.0325 lb/MMBtu (or 20 ppmv). The following section details the assumptions made for the emission reduction analysis, and describes the research and equations used to estimate the total NOx emission reductions upon full implementation at the end of 2036.

[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.

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 from the November 2009 and September 2014 amendments to Rule 1111[2,3]; the California Air Resources Board (CARB) emissions inventory[4]; 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) x (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 0.093 lb/MMBtu (or 55 ppmv) NOx emission limit. Although reductions would be achieved from units installed in manufactured homes after the proposed 0.0325 lb/MMBtu (or 20 ppmv) NOx emission limit is implemented in 2018, these

[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 NOx 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.

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 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:

   = (total gas furnace capacity / total heating capacity of all units)
   = (12,494 MMBtu/ 17,805 MMBtu) = 70.2%

5. Because the ARB emission inventory only projects up to 2035, an estimate was made for NOx 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 NOx emission factor (EF) for commercial units is the same as the baseline NOx EF for residential units because the units are essentially the same; therefore, the baseline NOx EF for residential and commercial units is assumed to be the current Rule 4905 limit of 0.093 lb/MMBtu (or 55 ppmv).

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.

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:

$Baseline_{residential\ total\ (in\ 2036)}$ = Baseline residential emissions in 2035 + average annual increase in emissions from 2031-2035
= 3.21 tpd (in 2035) + {[3.21 tpd (in 2035) – 3.05 tpd (in 2031)]/5}
= 3.24 tpd (in 2036)

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:

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

$Baseline_{commercial\ net}$ = Baseline emissions from furnaces used in commercial buildings
= (% of heating capacity for gas furnaces in Valley) x ($Baseline_{commercial\ total}$)
= (70.2%) x (1.31 tpd)
= 0.92 tpd (in 2036)

$Baseline_{total}$ = $Baseline_{residential}$ + $Baseline_{commercial}$
= 3.24 tpd + 0.92 tpd
= 4.16 tpd (in 2036)

C. Annual Reductions

The number of units purchased each year is projected to rise continually during the implementation period; however, the District would only 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 implementation reached at the end of 2036. The annual reductions were calculated as follows:

Annual Reductions = (emissions from 5% of units replaced annually, starting in 2017) x (reduction in NOx EF)
= (net baseline emissions in 2017) x (0.05) x [1-(0.0325 lb/MMBtu/0.093 lb/MMBtu)]

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:

$Baseline_{manufactured\ homes}$ = ($Baseline_{residential\ total}$) x (% population in mobile homes) x (% of mobile homes using natural gas)
= 2.54 tpd (in 2017) x (3.5%) x (70%)
= 0.06 tpd (in 2017)

$Baseline_{residential\ net}$ = Baseline emissions from residential units with emissions from manufactured homes removed
= $Baseline_{residential\ total}$ (from CARB emission inventory)[7] – $Baseline_{manufactured\ homes}$
= 2.54 tpd (in 2017) – 0.06 tpd (in 2017)
= 2.48 tpd (in 2017)

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

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

$Annual\ Reductions_{residential}$ = ($Baseline_{residential\ net}$) x (5% of units replaced annually) x (reduction in NOx EF)
= (2.48) x (0.05) x [1-(0.0325 /0.093)]
= 0.081 tpd

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

$Baseline_{commercial\ net}$ = Baseline emissions from furnaces used in commercial buildings
= (% of heating capacity attributed to gas furnaces in Valley) x ($Baseline_{commercial\ total}$)
= 70.2% x 1.07 tpd (in 2017)
= 0.75 tpd (in 2017)

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

$Annual\ Reductions_{commercial}$ = ($Baseline_{commercial\ net}$) x (5% of units replaced annually) x (reduction in NOx EF)
= (0.75) x (0.05) x [1-(0.0325 /0.093)]
= 0.025 tpd

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

$Annual\ Reductions_{total}$ = ($Reductions_{residential}$ + $Reductions_{commercial}$)
= 0.106 tpd total annual NOx emission reductions

D. Percent Reduction upon Full Implementation at the End of 2036

The percent reduction upon full implementation 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 implementation at the end of 2036 is calculated as follows:

Final reductions	=	(Total annual reductions) x (20 years implementation period)
	=	0.106 tpd/year x 20 years
	=	2.12 tpd
Final Percent Reduction	=	(Final reductions/Baseline emissions in 2036) x 100%
	=	2.12 tpd/4.16 tpd x 100%
	=	51.0% total percent reduction in NOx emissions upon full implementation in 2036

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 2.12 tpd would occur upon full implementation 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	2.12
NOx Emission Inventory with Proposed Amendments Implemented	2.94	2.64	2.34	2.04