APPENDIX B

Emission Reduction Analysis
For Draft Amendments to Rule 4308

August 22, 2013

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EMISSION REDUCTION ANALYSIS FOR DRAFT RULE 4308

I. SUMMARY

Draft rule amendments reduce NOx emissions by lowering the NOx emission limit from 55 ppmv to 20 ppmv for instantaneous water heaters with a rated heat input of 0.075-0.4 MMBtu/hr (instantaneous units), as committed to in the *2012 PM2.5 Plan*. As a point-of-sale rule, emission reductions will be achieved gradually as older units are replaced over the next 20 years.

The *2012 PM2.5 Plan* did not specify an emissions reduction commitment for this draft rule amendment; therefore, there is no comparison between a plan emission reduction commitment and the draft rule emissions reduction. The number of units in the San Joaquin Valley (Valley), baseline NOx emissions, and estimated NOx emissions reduction are summarized in Table B-1 below.

Table B-1: Summary of Baseline Emissions and Emission Reductions from Instantaneous Units with a Rated Heat Input of 0.075-0.4 MMBtu/hr

Number of Units in the Valley	2013 Baseline NOx Emissions Inventory (tons per year, or tpy)	NOx Reductions Upon Full Implementation in 2035 (tpy)	Percent Reduction from Baseline
609	1.10	0.73	66.4%

II. BACKGROUND

Rule 4308 applies to any person who supplies, sells, offer for sale, installs, or solicits the installation of boilers, steam generators, or process heaters with a rated heat input of 0.075 MMBtu/hr to less than 2.0 MMBtu/hr. The draft rule amendment generating NOx emission reductions in this rule project is targeted at instantaneous water heaters with a rated heat input of 0.075 MMBtu/hr to 0.4 MMBtu/hr. The draft rule amendment would require that these instantaneous water heaters supplied, sold, or installed in the Valley meet a 20 ppmv NOx emission limit. These types of units are used in a variety of commercial and residential settings.

Since this draft rule amendment is affecting a small subcategory of units subject to Rule 4308, the baseline NOx emissions inventory for these instantaneous units is considerably smaller than the total NOx emission inventory for this source category. Table B-2 below illustrates the NOx emission inventory for all units subject to Rule 4308. As demonstrated in this appendix, the 2013 baseline emissions inventory for instantaneous units affected by draft rule amendments is 1.10 tpy.

Table B-2: Rule 4308 Annual Average NOx Emissions Inventory from the *2012 PM2.5 Plan*

Year	2012	2014	2015	2016	2017	2018	2019
NOx Emissions (tpy)	259.15	233.6	219	211.7	204.4	197.1	193.45

III. EMISSION REDUCTION ANALYSIS

A. Assumptions for the Emission Reduction Analysis

District staff gathered data from manufacturers, previous District staff reports, Department of Energy (DOE) data, and the 2006 South Coast Air Quality Management District (SCAQMD) Rule 1146.2 staff report to determine emission capacity factors, average usage rates, emission rates, and average unit size.

The District sent out a survey to gather information on the number of units in this size category in 2009; however, only 50% of surveys were returned, and most of them did not contain any information on the number of units for this size category. Therefore, District staff calculated an average population-to-unit ratio, using data from the SCAQMD website[1] and an estimate for the total number of units in the 0.075-0.4 MMBtu/hr size category in the SCAQMD from the Rule 1146.2 staff report.[2]

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

1. **Population-to-Unit Ratio:** For every 385 people, there is one unit in the size range of 0.075 MMBtu/hr to 0.4 MMBtu/hr.

   SCAQMD Population = 16,800,000 people
   SCAQMD # of units with a rated heat input of 0.075-0.4 MMBtu/hr = 43,600 units

   SCAQMD Population-to-Unit Ratio = (Population) / (# of Units)
   SCAQMD Population-to-Unit Ratio = (16,800,000) / (43,600)
   SCAQMD Population-to-Unit Ratio = 385 people for every 1 unit
   SCAQMD Population-to-Unit Ratio = 1 unit/385 people

[1] SCAQMD: About South Coast AQMD. (2012, October 9). Retrieved May 7, 2013 from http://www.aqmd.gov/aqmd/index.html
[2] SCAQMD. (2006, May 5). *Staff Report for Proposed Amended Rule 1146.2- Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters.* Diamond Bar, CA. Retrieved from http://www.aqmd.gov/hb/2006/may/060535a.html

2. **Valley Population:** A Valley population of 3,970,900 people is assumed, based on 2010 data from Valley Metropolitan Planning Organizations (MPOs).[3]

3. **% Instantaneous:** The DOE's *2009 Water Heater Market Profile* estimates that 3% of water heaters sold are natural gas-fired tankless (instantaneous) units, 48% sold are natural gas-fired storage units, and the remaining 49% sold are electric units. Therefore, natural gas-fired instantaneous units make up 5.9% of the natural gas-fired water heater market.

   $$\% \text{ of gas units that are instantaneous} = \frac{(\% \text{ of gas instantaneous})}{(\% \text{ of gas instantaneous} + \% \text{ gas storage})} \times 100$$

   $$\% \text{ of gas units that are instantaneous} = \frac{(0.03)}{(0.03+0.48)} \times 100$$

   % of gas units that are instantaneous = 5.9%

4. **Total Units:** Using the population-to-unit ratio, the District calculated a conservative estimate of the total number of instantaneous units in the Valley affected by these draft rule amendments for the purposes of this emission reduction analysis. This figure is conservative because it only assumes the replacement of existing instantaneous units with newer instantaneous units. The District anticipates additional emission reductions as a result of these draft amendments due to the trend of replacing tank-style units with instantaneous units because of increased fuel and energy efficiency, but will not claim those emission reductions for this rule-amending project.

5. **Capacity Factor:** A 0.22 capacity factor will be used to calculate the baseline emissions from a 55 ppmv limit and potential emissions from a 20 ppmv limit.[4] The capacity factor represents the fraction of fuel actually burned or consumed by the unit in a year compared to the theoretical maximum amount of fuel that a unit could use in a year.

6. **Average Rating:** An average rating is applied to the 0.075 MMBtu/hr and 0.4 MMBtu/hr size categories since the number of instantaneous units is assumed to be distributed evenly within this size range. Therefore, the average rating is 0.238 MMBtu/hr. Additionally, during research staff determined that most commonly available instantaneous units are rated with a heat input of 0.2 MMBtu/hr, further supporting the assumption.

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[3] San Joaquin Valley Air Pollution Control District [SJVAPCD]. (2012, December 20). *Appendix B (Emission Inventory), 2012 PM2.5 Plan*. Fresno, CA.

[4] SCAQMD. (2006, May 5). *Staff Report for Proposed Amended Rule 1146.2- Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers and Process Heaters.* Diamond Bar, CA. Retrieved from http://www.aqmd.gov/hb/2006/may/060535a.html

7. **Baseline Emission Rate:** The baseline emission rate assumes 100% of instantaneous units comply with the current NOx emission limit and operate with a NOx emission rate of 55 ppmv (0.068 lb NOx/MMBtu).

8. **Draft Emission Rate:** The draft emission rate assumes 100% of instantaneous units would comply with the draft NOx emission limit, upon full rule implementation, and operate with a NOx emission rate of 20 ppmv (0.024 lb NOx/MMBtu).

9. **Commercial Average Daily Use ($ADU_{commercial}$):** Average usage is 1,000 gallons/day (gal/day) for commercial and industrial water heaters.[5]

10. **Residential Average Daily Use ($ADU_{residential}$):** Average residential water heater usage is 27-135 gal/day. District staff averaged this range and assumes that average residential water heater usage is 81 gal/day.[6]

11. **Average Water Output Rate:** The average water output rate for instantaneous water heaters is 2-5 gallons/minute (gal/min).[7] District staff assumes the average water output rate is 3.5 gal/min.

12. **Lifetime of an Instantaneous Unit:** Instantaneous units have an estimated lifetime of 20 years.[8]

13. **Percentage of Emissions Reductions Achieved Each Year:** Since the lifetime of an instantaneous unit is 20 years, staff assumes each year 5% of the total NOx emission reductions (approximately 0.04 tpy) are expected to occur.

B. Total Number of Instantaneous Units with a Rated Heat Input of 0.075-0.4 MMBtu/hr in the Valley

Total Units = (Population-to-Unit Ratio) x (Valley Population) x (% Instantaneous)

Total Units = (1 unit/385 people) x (3,970,900 people) x (0.059)

Total Units = 609

[5] United States Department of Energy [DOE]: Office FEMP Designated Product: Commercial Gas Water Heaters. (2012). Retrieved June 11, 2013 from http://www1.eere.energy.gov/femp/technologies/m/eep_com_gaswaterheaters.html#foot4

[6] Energy Center of Wisconsin. (2010). *Energy Use by Residential Gas Water Heaters.* Retrieved from http://www.ecw.org/ecwresults/254-1.pdf

[7] United States Department of Energy [DOE]: Tankless or Demand-Type Water Heaters. (2012). Retrieved June 11, 2013 from http://energy.gov/energysaver/articles/tankless-or-demand-type-water-heaters

[8] Department of Energy [DOE]: Tankless or Demand-Type Water Heaters. (2012). Retrieved June 11, 2013 from http://energy.gov/energysaver/articles/tankless-or-demand-type-water-heaters

C. Average Daily Usage (ADU)

$ADU_{gallons} = (ADU_{residential} + ADU_{commercial}) / 2$
$ADU_{gallons} = (81 \text{ gal/day} + 1{,}000 \text{ gal/day}) / 2$
$ADU_{gallons} = 540.5 \text{ gal/day}$

$ADU_{hours} = (ADU_{gallons}) / (\text{Average Water Output Rate} \times 60 \text{ min/hr})$
$ADU_{hours} = (540.5 \text{ gal/day}) / (3.5 \text{ gal/min} \times 60 \text{ min/hr})$
$ADU_{hours} = 2.6 \text{ hours/day}$

D. Baseline NOx Emissions Based on Current NOx Emission Limit of 55 ppmv ($Emissions_1$)

$Emissions_1$ = (Total Units) x (Average Rating) x (Baseline Emission Rate) x (Capacity Factor) x (ADU_{hours}) x (ton/lb)

$Emissions_1$ = (609) x (0.238 MMBtu/hr) x (0.068 lb NOx/MMBtu) x (0.22) x (2.6 hours/day) x (1 ton/2,000 lb)

$Emissions_1$ = 0.003 tons of NOx/day (tpd)

E. Potential NOx Emissions Based on Draft NOx Emission Limit of 20 ppmv ($Emissions_2$)

$Emissions_2$ = (Total Units) x (Average Rating) x (Draft Emission Rate) x (Capacity Factor) x (ADU_{hours}) x (ton/lb)

$Emissions_2$ = (609) x (0.238 MMBtu/hr) x (0.024 lb NOx/MMBtu) x (0.22) x (2.6 hr/day) x (1 ton/2,000 lb)

$Emissions_2$ = 0.001 tpd

F. Total Emission Reductions (TER)

$TER = (Emissions_1) - (Emissions_2)$
$TER = 0.003 \text{ tpd} - 0.001 \text{ tpd}$
$TER = 0.002 \text{ tpd}$

$TER = (0.002 \text{ tpd}) \times (365 \text{ days/year})$
$TER = 0.73 \text{ tpy}$

TER = 0.73 tpy (0.002 tpd)

G. Total % of Baseline Emissions Reduced

Baseline Emissions (tpy) = ($Emissions_1$) x (365 days/year)
Baseline Emissions (tpy) = (0.003 tons/day) x (365 days/year)

Baseline Emissions (tpy) = 1.10 tpy

Total % of Baseline Emissions Reduced = [(TER) / (Baseline Emissions)] x 100
Total % of Baseline Emissions Reduced = [(0.73 tpy) / (1.10 tpy)] x 100

Total % of Baseline Emissions Reduced = 66.4%

IV. CONCLUSION

Since this is a point-of-sale rule, the NOx emission reductions from this draft rule amendment will occur gradually as instantaneous units are replaced between 2015 and 2035. The total emissions reductions of 0.73 tpy will occur upon full rule implementation in 2035. Table B-3 illustrates the cumulative NOx emission reductions over this 20 year period.

Table B-3: Cumulative NOx Emission Reductions from Draft Rule 4308

Year	2020	2025	2030	2035
NOx Emission Reductions (tpy)	0.18	0.37	0.55	0.73