SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT

Preliminary Draft Staff Report
Proposed Amended Rule 1146.1 - Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters

April 2008

Deputy Executive Officer
Planning, Rule Development, and Area Sources
Elaine Chang, DrPH

Assistant Deputy Executive Officer
Planning, Rule Development, and Area Sources
Laki Tisopulos, Ph.D., P.E.

Planning and Rules Manager
Planning, Rule Development, and Area Sources
Joe Cassmassi

Author: Rizaldy Calungcagin, Air Quality Specialist

Reviewed by: Gary Quinn, P.E. – Program Supervisor
Kurt Wiese - District Counsel

SOUTH COAST AIR QUALITY MANAGEMENT DISTRICT
GOVERNING BOARD

Chairman: WILLIAM A. BURKE, Ed.D.
Speaker of the Assembly Appointee

Vice Chairman: S. ROY WILSON, Ed.D.
Supervisor, Fourth District
Riverside County Representative

MEMBERS:

MICHAEL D. ANTONOVICH
Supervisor, Fifth District
Los Angeles County Representative

MICHAEL A. CACCIOTTI
Mayor, City of South Pasadena
Cities Representative, Los Angeles County, Eastern Region

BILL CAMPBELL
Supervisor, Third District
County of Orange

JANE W. CARNEY
Senate Rules Committee Appointee

RONALD O. LOVERIDGE
Mayor, City of Riverside
Cities Representative, Riverside County

JOSEPH K. LYOU, Ph.D.
Governor's Appointee

GARY OVITT
Supervisor, Fourth District
San Bernardino County Representative

JAN PERRY
Councilmember, City of Los Angeles
City of Los Angeles

MIGUEL PULIDO
Mayor, City of Santa Ana
Cities Representative, Orange County

TONIA REYES URANGA
Councilmember, City of Long Beach
Cities Representative, Los Angeles County, Western Region

DENNIS YATES
Mayor, City of Chino
Cities Representative, San Bernardino County

EXECUTIVE OFFICER:

BARRY R. WALLERSTEIN, D.Env.

TABLE OF CONTENTS

EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

Rule 1146.1 – Emissions of Oxides of Nitrogen from Small Industrial, Institutional, and Commercial Boilers, Steam Generators, and Process Heaters was adopted on October 5, 1990. This rule applies to existing boilers, steam generators, and process heaters with maximum rated heat input capacities greater than 2 million BTU per hour and less than 5 million BTU per hour. Rule 1146.1 establishes NOx and CO emission limits, and provides compliance options for units that meet low fuel usage thresholds.

The rule does not apply to NOx RECLAIM facilities. Instead, the units in the Rule 1146.1 size range are subject to NOx limits established through the RECLAIM program.

The proposed amendment to this rule would reduce the allowable emission limits of NOx from units with the application of low-NOx or ultra low-NOx burners with or without the use of flue gas recirculation (FGR). It is also the intent of this proposed amendment to harmonize the NOx compliance limits with those limits proposed for Rule 1146 and established in Rule 1146.2. The following table presents the proposed NOx emission limits and compliance dates.

Table ES – 1
Proposed NOx Limits and Compliance Dates

Category	Limit	Permit to Construct	Full Compliance
Any Units Fired on Landfill Gas	25 ppm	January 1, 2014	January 1, 2015
Any Units Fired on Digester Gas	15 ppm	January 1, 2014	January 1, 2015
Any Units Fired on Natural Gas, Excluding Units Located at Schools and Universities	9 ppm or 0.011 lbs/10^6 Btu	January 1, 2011	January 1, 2012
Any Units Fired on Natural Gas Located at Schools and Universities		January 1, 2013	January 1, 2014

The proposed rule amendment also introduces:

- A weighted average formula for duel fueled co-fired units
- Recognition of energy efficient units
- Compliance testing frequency compatible with RECLAIM sources in the same size range
- Monitoring NOx emissions with a portable analyzer
- Ending the derating of existing units

- Compliance with the 30 ppm NOx limit for low fuel usage units by January 1, 2015 or burner replacement, whichever occurs later
- Extending the compliance date for health facilities complying with seismic safety requirements

The proposed rule amendment is estimated to reduce approximately 0.29 tons per day of NO_x emissions by 2015. Preliminary cost effectiveness estimates range from $8,400 to $20,600 per ton. The cost differential is attributed to unit size, types of burners, and the unit's operation and load. The preliminary incremental cost effectiveness ranges from $110,900 to $231,000 per ton (ultra low-NOx burner compared to SCR).

CHAPTER 1: BACKGROUND

INTRODUCTION

REGULATORY HISTORY

TYPES OF BOILERS AND HEATERS

TECHNOLOGY ASSESSMENT

AFFECTED INDUSTRIES

PUBLIC PROCESS

INTRODUCTION

Rule 1146.1 applies to existing boilers, steam generators, and process heaters with maximum rated heat input capacities greater than 2 million BTU per hour and less than 5 million BTU per hour. The rule does not apply to units in NOx RECLAIM facilities. Instead, the units in the Rule 1146.1 size range are subject to NOx limits established through the RECLAIM program.

REGULATORY HISTORY

Rule 1146.1 was originally adopted in October 5, 1990 and developed pursuant to the 1989 Air Quality Management Plan (AQMP) of the South Coast Air Quality Management District (AQMD). As adopted, the rule applied to new and existing boilers, steam generators, and process heaters with a maximum rated heat input greater than or equal to 2 million BTU per hour and less than 5 million BTU per hour. The rule established a 30 ppm NOx emission limit for units with an annual heat input greater than 18,000 therms. For units that did not exceed an annual heat input of 18,000 therms the owner or operator must either install a non-resetting fuel use totalizing meter or provide fuel use bills from a fuel supply company based on metering of fuel use indicating less than 18,000 therms per year of heat input per unit. In addition these low fuel usage units must comply with the rule by either semiannual tune-ups or maintaining stack gas oxygen concentrations at less than 3 percent on a dry basis.

At the time of the original rule adoption there were about 2,700 units in the District with a gross heat input between 2 and 5 million BTU per hour. However, in 1993 about 58% of these units were no longer subject to Rule 1146.1 and instead subject to the RECLAIM program.

The first amendment occurred in July 10, 1992. The amendment was the result of an ARB notification to the AQMD on February 14, 1992, of certain deficiencies in Rule 1146.1. These amendments corrected these deficiencies and other concerns raised by the EPA, prior to the rule's emission limits taking effect on July 1, 1994. The 1992 amendments specified either District Method 100.1 as the required test method for NOx, CO and O_2, or Methods 7.1 for NOx and 10.1 for CO and O_2.

The method of determining emission in pounds per million Btu was not explained in the rule. The 1992 amendment specified that the method in the Code of Federal Regulations, Title 40, Part 60, Appendix A, Method 19, Sections 2 and 3 must be used for this determination. EPA uses this method to convert the NOx concentration measured in the stack flue gas of a utility boiler to an emission rate in pounds per million Btus. For standard fuels such as fuel oil or natural gas, only measurements of NOx and O_2 concentrations in the flue gas are required to make the conversion. The conversion is based on combustion stoichiometry and is applicable to boilers and heaters regardless of size.

Other amendments in 1992 affected alternative tune-up procedures and limiting the start-up and shutdown period of exemption to a maximum of 6 hours.

In May 13, 1994 Rule 1146.1 was amended to add a tune up procedure for natural-draft units. This addition provided guidelines for tuning natural draft-fired units that have not exceeded 18,000 therms per year gross heat input from all fuels burned. This was deemed necessary since natural-draft boilers acquire combustion air by natural draft created by their stacks do not have combustion air fans or blowers.

For this amendment the applicability section was changed to apply to boilers with a rated heat input greater than two million Btu per hour in order to conform to District Rule 219.

Based on industry input, a requirement for approval by USEPA, CARB, and District of equivalent tune up procedures was removed to allow more flexibility of implementation. Also, no tune up was required for units that are not used during the whole calendar year. At the request of the ARB, applicability of the rule was extended to units fired on solid fuels.

The District's 2007 AQMP was adopted in June of 2007. Included within the 2007 AQMP was Control Measure MCS-01, Facility Modernization. Control Measure MCS-01 affects a wide variety of permitted equipment and processes, including boilers, steam generators, and process heaters that are subject to Rule 1146.1. PAR 1146.1 may incorporate the facility modernization concept as a means of implementing this control measure. Through the facility modernization concept, as a boiler, steam generator, or process heater ages and reaches the end of useful life, the unit is either upgraded or replaced to meet NOx emissions limits that are consistent with current BACT. This ensures timely upgrade of existing technology to the cleanest emission levels available. Based on the 18 years from initial rule compliance (July 1, 1994) to the first proposed compliance date (i.e., January 1, 2012) there appears to an already well developed turnover of Rule 1146.1 burners.

In October 2000 Non-Major Source BACT approved a 12 ppm limit for units fired on natural gas in the 2 to 5 mmbtu/hr size range.

TYPES OF BOILERS, STEAM GENERATORS, AND PROCESS HEATERS

There are many of types of boilers, water heaters and process heaters subject to AQMD Rule 1146.1. Boilers and steam generators produce hot water or steam for office buildings, commercial establishments, hospitals, schools and universities, hotels and industrial operations. Process heaters are used to heat material streams for industrial operations. Process heaters can heat process fluids directly or use a heat exchange fluid. For each application there may be several designs of boilers or heaters available. Boilers and heaters can be classified in several ways including the way heat is transferred, the material used in the heat exchanger, and the engineering and safety codes for which the unit is designed to comply.

A unit is classified as a boiler if it is designed to meet the safety standards of the American Society of Mechanical Engineers (ASME) Boiler and Pressure Vessel Code. While many boilers are used to produce steam, others provide hot water for a variety of purposes. The components and the entire system of a boiler must meet additional standards including those from

Underwriters Laboratories (UL), federal and state energy efficiency standards and local building codes.

Boilers

Historically, boilers have been built using one of three basic designs: fire tube, water tube or cast iron sectional. In a fire tube boiler, the combustion gasses pass through banks of narrow tubes that are surrounded by a pressure vessel (tank) which contains water. The combustion gasses may pass through one set of tubes in one direction (one pass) or make multiple passes by alternating the direction through each set of tubes. Multiple passes of the hot combustion gasses through the pressure vessel increase efficiency and increase the temperature and pressure of the water or steam. This type of boiler can be built using a horizontal pressure vessel and horizontal tubes or a vertical pressure vessel and tubes.

In a water tube boiler, the combustion gasses pass over and through banks of tubes containing water. Increasing the number and surface area of water tubes will increase the temperature and pressure of water in the tubes and increase the boiler efficiency. Steel water tube boilers can produce very high temperature water or high pressure steam.

Cast boilers pass combustion gasses over the surface of one or more water containing sections made of cast iron. Cast boiler sections can also be made from brass or bronze. This type of boiler can only be used to produce low temperature water or low pressure steam.

A newer type of boiler based on the water tube design uses a heat exchanger made of copper tubes with heat exchange fins. This type of boiler is typically constructed in a factory while the older designs may be constructed at the factory or at the location where the unit will be used.

TECHNOLOGY ASSESSMENT

In the combustion process, thermal NOx is generally the largest contributor of NOx emissions. High flame temperatures trigger the disassociation of nitrogen molecules from combustion air and a chain reaction with oxygen follows to form oxides of nitrogen. Factors that minimize the formation of thermal NOx include reduced flame temperature, shortened residence time, and an increased fuel to air ratio.

For gaseous fuels, the formation of fuel NOx is not significant. Fuel NOx results when nitrogen that is bound in fuel combines with oxygen present in combustion air. Because gaseous fuels typically have low nitrogen levels, this mechanism does not play a significant role in NOx formation during natural gas combustion. Similarly, fuel NOx formation does not play a significant role in the combustion of diesel fuel. This fuel is the only non-gaseous fuel used in significant quantities within the South Coast Air Basin. California has stringent low sulfur standards for diesel fuel. The process used for removing sulfur also removes nitrogen, resulting in diesel fuel with low nitrogen levels.

Prompt NOx forms quickly and is a reaction of free radicals that primarily occurs in a fuel rich flame zone within the early stages of combustion. Although prompt NOx is generated in small quantities, it can play a significant role when attempting to achieve single-digit NOx levels.

To reduce NOx emissions, combustion parameters can be optimized, control techniques can be applied downstream of the combustion zone, or a combination of the two approaches can be utilized. Common types of combustion modification include: lowered flame temperature; reduced residence time at high combustion temperature; and reduced oxygen concentration in the high temperature zone. For purposes of complying with the proposed Rule 1146.1 limits the ensuing discussion will be limited to the application of the ultra low-NOx burner systems.

Ultra Low-NOx Burner Systems

Often, fuel and air are pre-mixed prior to combustion. This results in a lower and more uniform flame temperature. Some premix burners also use staged combustion with a fuel rich zone to start combustion and stabilize the flame and a fuel lean zone to complete combustion and reduce the peak flame temperature.

Burners can also be designed to spread flames over a larger area to reduce hot spots and lower NO_x emissions. Radiant premix burners with ceramic, sintered metal or metal fiber heads spread the flame and produce more radiant heat. When a burner produces more radiant heat, it results in less heat escaping the boiler through the exhaust gases.

Most premix burners require the aid of a blower to mix the fuel with air before combustion takes place (primary air). Flue gas recirculation (FGR), which recycles a portion of the exhaust stream back into the burner, is also commonly used. Increasing the amount of primary air and/or use of FGR can reduce flame temperature but it also reduces the temperature of combustion gases through dilution and can reduce efficiency. To maintain efficiency a manufacturer may have to add surface area to the heat exchanger. Increasing the primary air may also destabilize the flame. Ultra-low NO_x burners require sophisticated controls to maintain emissions levels and efficiency, to stabilize the flame, and to maintain a turndown ratio that is sufficient for the demands of the particular operation.

Ultra low-NO_x burner systems for boilers and process heaters can achieve less than 9 ppm NO_x (at 3% oxygen). NOx formation results primarily from thermal NOx and fuel NOx, and to a lesser extent from prompt NOx.

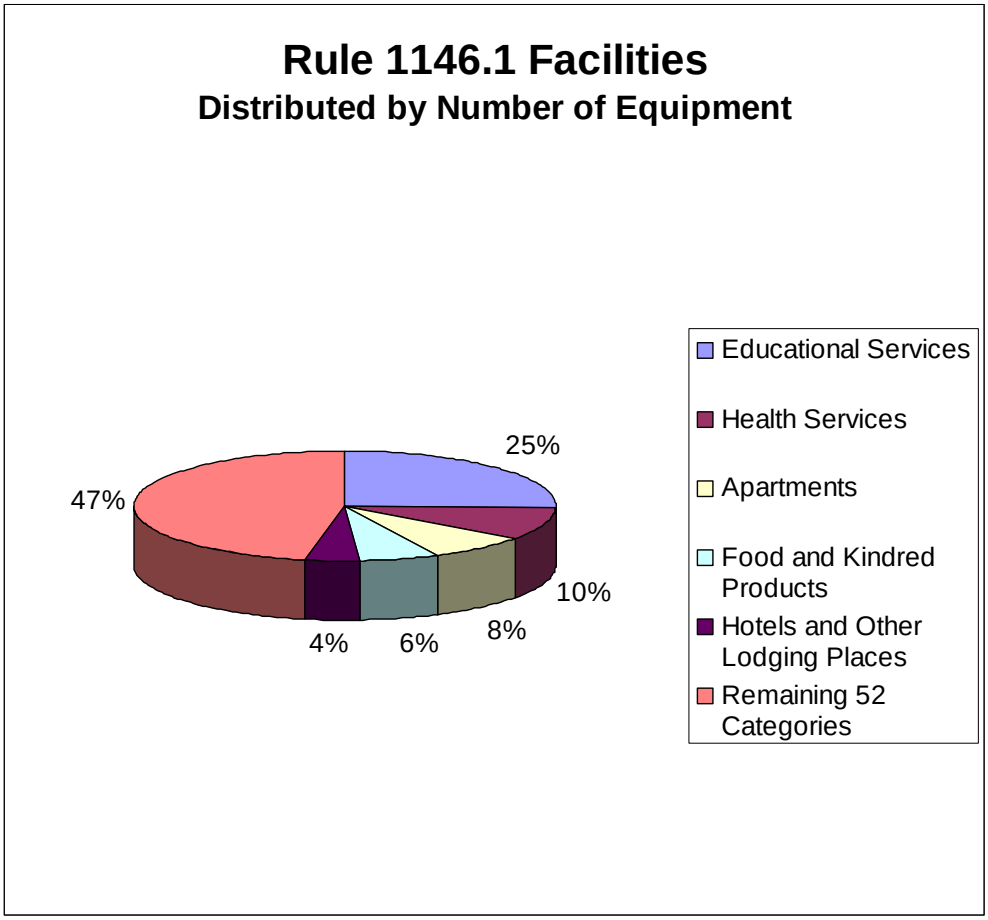
Ultra low-NOx Burners have been applied by the San Joaquin Valley Unified APCD (SJVUAPCD) in their Rule 4306. The compliance limit when applying this technology to equivalent boilers and heaters at the upper end of Rule 1146.1 (i.e., 5 mmbtu/hr) ranges from 9 to 15 ppm. In their March 17, 2008 proposed amended rule 4307, for equivalent units in the 2 to 5 mmbtu/hr range the limit is 9 ppm. This would apply to new and replaced units effective upon installation on or after January 1, 2010.

In May 2006 AQMD Rule 1146.2 (affecting units between 75,000 btu/hr and 2 mmbtu/hr) established a NOx limit of 20 ppm. SJVUAPCD is proposing to amend Rule 4306. The current proposal is 9 ppm for all equipment down to 5 mmbtu/hr. The proposed compliance date for PAR 4306 is June 1, 2011.

AFFECTED INDUSTRIES

Rule 1146.1 affects a wide variety of operations within the South Coast Air Basin. When grouped according to the Standard Industrial Classification (SIC), the educational services has about 25% of the units, health services industry has approximately 10% of the units that are subject to Rule 1146.1. Next, apartments comprise 8% of the units and the food industry contributes about 6% of the total. Hotels and other lodging places have about 4% share of the total Rule 1146.1 units. The remaining 47% of the units are distributed over 52 SIC categories.

Figure 1



Staff estimated that there are over 1,146 active permitted units in the District in the size range affected by this rule (i.e., 2 to 5 MM Btu/hr). The total estimated NOx emission from these units is 0.41 tons per day. This estimate was taken from AQMD emission database for the year 2002.

PUBLIC PROCESS

The rule development process started with the PAR 1146 effort. This has been ongoing process to assess low NO_x technologies for boilers, steam generators, and process heaters. There have been five Rule 1146 Task Force meetings from January 2006 to January 2008. These meetings included representatives from the manufacturers, trade organizations, permit holders for units subject to Rule 1146, and other interested parties. At these meetings low NO_x technology, equipment useful lives, and proposed emission limits were discussed.

In parallel with further Rule 1146 rule development efforts, staff held a Rule 1146.1 Task Force meeting on February 5, 2008 and a Public Consultation meeting on March 19, 2008. In assessing applicable technology staff has held individual meetings with manufacturers of boilers, steam generators, and process heaters.

CHAPTER 2: SUMMARY OF PROPOSED AMENDED RULE 1146.1

PROPOSED AMENDED RULE 1146.1 REQUIREMENTS

PROPOSED AMENDED RULE 1146.1 REQUIREMENTS

Existing Rule

Rule 1146.1 applies to new and existing industrial, institutional and commercial boilers, steam generators, and process heaters with a heat input between 2 and 5 MMBtu/hr.

The rule does not apply to units in NOx RECLAIM facilities. Instead, the units in the Rule 1146.1 size range are subject to NOx limits established through the RECLAIM program.

Under Rule 1146.1, units burning liquid, gaseous, and/or solid fuels are required to meet a NOx limit of 30 ppm limit and a CO limit of 400 ppm, if annual fuel usage exceeds 18,000 therms per year.

Fuel metering requirements apply to units exempt from NOx limits due to low fuel usage. Units that are exempt from NOx limits are also required to either maintain stack gas oxygen concentrations at 3% or less (on a dry basis), or tune the unit(s) at least twice per year according to specified tuning procedures.

All NOx limits are specified in ppm by volume at 3% oxygen. An alternative to meeting a 30 ppm NOx limit is to meet 0.037 pounds per 10^6 Btu of heat input.

Proposed Rule Amendments

Applicability – Subdivision (a):
Other than placing this subdivision ahead of the "Definitions" subdivision, there are no changes proposed for this subdivision.

Definitions – Subdivision (b):
There was added a definition of health facilities. This definition was added to take into consideration an extension in the compliance date for health facilities complying with seismic safety requirements.

Requirements – Subdivision (c):
There is a carryover of the current NOx compliance limit of 30 ppm or 0.037 lb NOx per 10^6 Btu. At the time of rule adoption this limit would apply to all units, except low fuel usage units (i.e., less than or equal to 18,000 therms per year). The proposed NOx compliance limits and schedule are presented in Table 1.

Table 1
Proposed NOx Limits and Compliance Dates

Category	Limit	Permit to Construct	Full Compliance
Any Units Fired on Landfill Gas	25 ppm	January 1, 2014	January 1, 2015
Any Units Fired on Digester Gas	15 ppm	January 1, 2014	January 1, 2015
Any Units Fired on Natural Gas, Excluding Units Located at Schools and Universities	9 ppm or 0.011 lbs/10^6 Btu	January 1, 2011	January 1, 2012
Any Units Fired on Natural Gas Located at Schools and Universities		January 1, 2013	January 1, 2014

The proposed NOx limits for landfill and digester gas fired units are 25 and 15 ppm, respectively. These limits are based on source data of units operating in the district, allowing for a certain amount of buffer to assure compliance. The compliance schedule took into consideration compliance deadlines for recently amended Rule 1110.2 *Emissions from Gaseous- and Liquid- Fueled Engines*. This rule requires equipment operated by the same facilities to comply with requirements by July 1, 2012. The intent was not to require compliance limits from two different rules during the same time period for the same facilities.

Staff feels that the proposed NOx limits would be in harmony with the compliance limits proposed for Rule 1146.

The proposed rule amendment also introduces a weighted average formula for duel fueled co-fired units. The formula for calculating the weighted average compliance limit is as follows:

$$\text{Weighted Limit} = \frac{(CL_A \times Q_A) + (CL_B \times Q_B)}{Q_A + Q_B} \qquad \text{Equation 2-1}$$

Where:

CL_A = compliance limit for fuel A

CL_B = compliance limit for fuel B

Q_A = heat input from fuel A

Q_B = heat input from fuel B

This is an optional approach in determining a compliance limit. Other units with a primary and standby fuel may not want to utilize this approach. Instead owners or operators of these units would need to demonstrate compliance with the corresponding limit for each fuel.

In addition to recognizing fuel efficiency in the optional "lbs per 106 Btu of heat input" limit, an enhanced fuel efficiency formula to adjust allowable emission limits has been proposed. Advanced technology fuel efficient boilers may encounter difficulties controlling NOx emissions. The enhanced fuel efficiency formula will allow facilities to operate these efficient boilers while still achieving NOx emission reductions. The proposed fuel efficiency equations are as follows:

$$CL_a = CL \times ECF \qquad \text{Equation 2-2}$$

Where:

CL_a is the adjusted concentration, ppm

CL is the concentration limit specified in the rule for natural gas fired units, ppm

ECF is the efficiency correction factor.

The ECF must be 1.0 unless:

(i) The unit's operator has measured the unit's specific efficiency (EF_a), in compliance with ASME Performance Test Code PTC 4 – 1998, at the average firing rate of the unit; and

(ii) The ECF-corrected emission limit is made a condition of the unit's Permit to Operate.

The ECF is calculated as follows:

$$ECF = \frac{[\text{Measured } EF_a, \%]}{[\text{Benchmark}, \%]} \qquad \text{Equation 2-3}$$

ECF must not be less than 1.0.

It should be noted that staff is soliciting input for recognizing fuel efficiency. For example, staff is requesting recommendations for a Benchmark value or values along with supporting documentation. At stakeholder meetings there were comments raised on the limitations of ASME Performance Test Code PTC 4 – 1998 for certain categories of units. Staff requested the identification of other replacement performance criteria for assessing efficiency. If such

information is not identified it is likely that this enhanced fuel efficiency option will be removed from the proposal.

There is a special consideration for those units that had complied with the NOx BACT requirement of less than or equal to 12 ppm. Thus, for those units in lieu of complying with the 9 ppm NOx limit according to the schedule specified in Table 1 the owner or operator may opt to comply with the 9 ppm or 0.011 lbs/10^6 Btu NOx level within 15 years of the unit's burner(s) date of installation or modification.

Other proposed changes include clarification on the tune-up schedule for low fuel usage units and the use of a non-resettable totalizing fuel meter for each of the fuels in which the weighted average is applied.

Compliance Determination– Subdivision (d):
Language is added requiring boilers subject to this rule to conduct an emission determination at least 250 operating hours or at least 30 days after tuning or servicing of the unit, unless it is an unscheduled repair. In this same paragraph, pre-tests for emission determinations were prohibited.

Additional test methods, *Conditional Test Method CTM-030, Determination of Nitrogen Oxides, Carbon Monoxide, and Oxygen Emissions from Natural Gas-Fired Engines, Boilers and Process Heaters Using Portable Analyzers* and *ASTM D6522-00(2005) Standard Test Method for Determination of Nitrogen Oxides, Carbon Monoxide, and Oxygen Concentrations in Emissions from Natural Gas-Fired Reciprocating Engines, Combustion Turbines, Boilers, and Process Heaters Using Portable Analyzers*, have been added to the rule. These methods allow the owner or operator of a subject boiler to use a portable analyzer to determine emission compliance. Another alternative to source tests is the use of a continuous in-stack NOx monitor.

Compliance determination with the NOx and CO emission sources test requirements must be conducted once every five years. The current rule only required a source test to demonstrate initial compliance. This requirement was added to match the same type of requirement for similar size units in the RECLAIM program (ref: Rule 2012 (e)(1)(ii) and 2012(j)(4)).

Under the proposed amendment the owner or operator must check emissions with a portable NOx, CO and oxygen analyzer according to the *Protocol for the Periodic Monitoring of Nitrogen Oxides, Carbon Monoxide, and Oxygen from Units Subject to South Coast Air Quality Management District Rules 1146 and 1146.1*. This monitoring must be conducted quarterly or every 2,000 unit operating hours, whichever occurs later. If a unit is in compliance for four consecutive emission checks, without any adjustments to the oxygen sensor set points, then the unit may be checked semi-annually or every 4,000 unit operating hours, whichever occurs later, until there is a noncompliant emission check.

Records of all monitoring data must be maintained for a rolling twelve month period of two years and made available to District personnel upon request. Any emission check conducted by District staff that finds excess emissions would be a violation.

If the source test or emission check finds NOx or CO emissions in excess of those allowed by the rule or a permit condition, the owner or operator must correct the problem and demonstrate compliance with another emission check, or shut down the unit by the end of an operating cycle, or within 72 hours from the time the owner or operator knew of excess emissions, or reasonably should have known, whichever is sooner.

Compliance Schedule– Subdivision (e):
The proposed schedule for compliance limits is presented in subdivision (c) "Requirements" (See Table 1 in this report). Schedule for other rule requirements are as follows:

- Owners and operators will have the option to derate their equipment. The lower rated capacity would be based on the manufacturer's rating plate or permit condition. The deadline for derating equipment is July 1, 2010.
- Boilers with an annual heat input less than or equal to 18,000 therms per year will be exempt from the proposed emission limits. However, these units would need to meet the 30 ppm or 0.037 lbs per 10^6 Btu NOx emission limit by January 1, 2015 or when the unit has its burners replaced, whichever occurs later.
- The requirement related to the loss of exemption for low fuel usage was moved from subdivision (f) of the current rule to this subdivision and modified to reflect reference to the proposed NOx compliance limits.
- A time extension would be granted to the full compliance date with the applicable NOx compliance limits for any natural gas fired units for any health facility as defined in Section 1250 of the California Health and Safety Code that can demonstrate that the Office of Statewide Health Planning and Development has approved an extension of time to comply with seismic safety requirements pursuant to Health and Safety Code Sections 130060 and 130061.5. The extension of time granted must be consistent with the time extension granted pursuant to Health and Safety Code Section 130060 but not to exceed January 1, 2015 and must be consistent with the time extension granted pursuant to Health and Safety Code Section 130061.5 but not to exceed January 1, 2020. Those health facilities granted a time extension must submit a compliance plan to the Executive Officer on or before January 1, 2010

Exemptions:
The 18,000 therm exemption will no longer apply to future units. On this basis, this subdivision has been removed.

Loss of Exemption:

The loss of exemption provision has been moved to subdivision (e) "Compliance Schedule".

Attachment 1:

Figures 1 and 2 have been re-introduced to Attachment. These example Oxygen/CO and Oxygen/Smoke characteristic curves were in the original adopted rule. Also some clarifying language was added to A.8 and B.1.e.ii.

Throughout PAR 1146.1 there are minor amendments to improve the clarity and enforceability of the rule. Compliance dates that have passed have been removed from the rule and equipment now subject to the same requirements has been consolidated into a single paragraph.

CHAPTER 3: IMPACT ASSESSMENT

IMPACT ANALYSIS

Staff has prepared a preliminary analysis of the impacts of PAR 1146.1. The proposed rule amendment is estimated to reduce approximately 0.29 tons per day of NO_x emissions by 2014. Emission reductions were calculated using the difference between the emission factor for the existing emission limit and the range in proposed emission factors presented in Table 1.

Emission data was extracted from operating data in the AQMD inventory database. Control efficiency for the ultra low-NOx burners was provided by venders. The estimated emission reductions also take into account units that may be exempt due to low fuel usages.

COST EFFECTIVENESS

Cost-effectiveness is defined as the cost to comply with the new regulatory requirements, expressed in terms of dollars per ton of pollutant reduced. Determination of cost-effectiveness is required by section 40440(c) of the California Health and Safety Code. Costs can include equipment, materials, energy, or any other costs associated with meeting new regulatory requirements.

The approach for estimating cost-effectiveness is as follows:

$$CE = \frac{(\$ \text{ Meet New Limits} - \$ \text{ Continue w/ Existing Limits} + \$ \text{ Early Retirement})}{\text{Emission Reductions from Existing to New Limits over Equipment Useful Life}}$$

This approach utilizes the Discount Cash Flow (DCF) Methodology at 4% real interest rate in current dollars. The assumed useful life for ultra-low NOx burners used in this cost effectiveness calculation is fifteen years. Fifteen years was applied in the recent amendments to Rule 1146.2 (May 2006).

The costs to meet the proposed emission limits were estimated from information obtained through manufacturers and vendors of units for the size range affected by Rule 1146.1. These estimates incorporate capital costs (including installation) for retrofitting equipment subject to this rule, and costs for any additional fuel and/or electricity use that are associated with meeting the more stringent NOx limits. For instance, some ultra low NOx burner systems require the use of additional excess air and/or flue gas recirculation. This reduces fuel efficiency and also requires the use of additional electricity for operation of the air blower. These additional costs were estimated using vendor data for excess air and flue gas recirculation.

In addition to the cost elements mentioned above, staff has also included any incremental costs associated with the proposed monitoring and testing requirements in determining total cost for meeting the new rule requirements. Proposed Amended Rule 1146.1 includes provisions for quarterly or semi-annual monitoring of NOx emissions using a portable analyzer, and source testing requirement every five years.

In estimating the total cost of continuing to meet the existing rule requirements, staff used equipment, operating and maintenance costs data obtained from various manufacturers and

vendors for units that meet the current 30 ppm NOx limit. This cost is deducted from the total cost of meeting the new limits in determining cost effectiveness of Proposed Amended Rule 1146.1.

The proposed rule amendment is estimated to reduce approximately 0.29 tons per day of NO_x emissions by 2016. Upon complete retrofit with 9 ppm burners the NOx reduction would be 0.29 tons per day.

Staff analysis shows that the cost effectiveness values improve for larger boiler sizes and higher operating capacity. Preliminary cost effectiveness estimates for units rated at 2 to 5 MMBtu/hr average from about $6,900 to $20,600 per ton of NOx reduced. The cost differential is attributed to unit size, types of burners, and the unit's operation and load. The table below shows the cost effectiveness values for the size range affected by Proposed Amended Rule 1146.1.

Table 2
Summary of Cost Effectiveness Analysis
2 to 5 MMBtu/hr

Operating Capacity Factor	Cost Effectiveness ($/ton NOx reduced)
100%	$6,900
75%	$8,400
50%	$11,500
25%	$20,600

CALIFORNIA ENVIRONMENTAL QUALITY ACT (CEQA) ANALYSIS

Pursuant to the California Environmental Quality Act (CEQA) and AQMD Rule 110, the AQMD will be preparing a Draft EA for the proposed amendments to Rule 1146.1. The Draft EA will be released for a 30-day public review period and comments received during this review period will be responded to and included in the Final EA. Upon its release, copies of the Draft EA for Rule 1146.1, can be obtained by calling the AQMD's Public Information Center at (909) 396-2039 or by downloading it from the AQMD's website at: http://www.aqmd.gov/ceqa/aqmd.html.

SOCIOECONOMIC ASSESSMENT

A socioeconomic analysis of the Rule 1146.1 amendments will be performed. The socioeconomic report will be released no later than 30 days prior to the Board hearing.

DRAFT FINDINGS UNDER CALIFORNIA HEALTH & SAFETY CODE SECTION 40727

California Health and Safety Code Section 40727 requires that prior to adopting, amending or repealing a rule or regulation, the AQMD Governing Board shall make findings of necessity, authority, clarity, consistency, non-duplication, and reference based on relevant information presented at the public hearing and in the staff report. In order to determine compliance with Sections 40727, 40727.2 require a written analysis comparing the proposed amended rule with existing regulations.

The draft findings are as follows:

Necessity: A need exists to amend Rule 1146.1 to reduce emission limits for small boilers and large water heaters in order to meet federal and state ambient air quality standards.

Authority: The AQMD obtains its authority to adopt, amend, or repeal rules and regulations from California Health and Safety Code Sections 39002, 40000, 40001, 40440, 40440.1, 40702, 40725 through 40728, 41508, and 41700.

Clarity: PAR 1146.1 has been written or displayed so that its meaning can be easily understood by the persons affected by the rule.

Consistency: PAR 1146.1 is in harmony with, and not in conflict with or contradictory to, existing federal or state statutes, court decisions or federal regulations.

Non-Duplication: PAR 1146.1 does not impose the same requirement as any existing state or federal regulation, and is necessary and proper to execute the powers and duties granted to, and imposed upon the AQMD.

Reference: In amending this rule, the following statutes which the AQMD hereby implements, interprets or makes specific are referenced: Health and Safety Code sections 39002, 40001, 40702, 40440(a), and 40725 through 40728.5.

INCREMENTAL COST-EFFECTIVENESS

Health and Safety Code Section 40920.6 requires an incremental cost-effectiveness analysis for Best Available Retrofit Control Technology (BARCT) rules or emission reduction strategies when there is more than one control option which would achieve the emission reduction objective of the proposed amendments, relative to ozone, CO, SOx, NO_x, and their precursors. Incremental cost effectiveness is defined as the difference in control costs divided by the difference in emission reductions between two potential control options that can achieve the same emission reduction goal of a regulation.

For this incremental cost effectiveness analysis, the cost and emission reduction associated with the use of selective catalytic reduction (SCR) to meet the more stringent 5 ppm NOx limit for units affected by PAR 1146.1 are compared to the control cost and emission reduction of the same units using ultra low-NOx burners meeting the 9 ppm NOx limit.

For SCR, staff considered various cost factors such as equipment and installation, electricity, ammonia, other operating and maintenance costs, and recurring catalyst replacement cost in

determining total cost. A 25-year useful life is assumed for SCR and 15 years for ultra low-NOx burners.

Staff's analysis indicates that the incremental cost effectiveness between SCR (5 ppm NOx limit) and ultra low-NOx burner (9 ppm NOx limit) ranges from $96,000 to $231,000 per ton of NOx reduced depending on the operating capacity of the unit. The table below shows the incremental cost effectiveness values for the size range affected by PAR 1146.1.

Table 3
Summary of Incremental Cost Effectiveness Analysis
2 to 5 MMBtu/hr

Capacity Factor (%)	Incremental Cost Effectiveness ($/ton NOx reduced)
100	$96,200
75	$110,900
50	$143,300
25	$231,000

COMPARATIVE ANALYSIS

Under Health and Safety Code Section 40727.2, the AQMD is required to perform a comparative written analysis when adopting, amending, or repealing a rule or regulation. The comparative analysis is relative to existing federal requirements, existing or proposed AQMD rules and air pollution control requirements and guidelines which are applicable to industrial, institutional, and commercial water heaters, boilers, steam generators, and process heaters. This analysis will be prepared for the proposed rule amendment's set hearing package.

REFERENCES

REFERENCES

SCAQMD, 2005. *Preliminary Draft Staff Report: Proposed Rule 1146.2 - Emissions of Oxides of Nitrogen from Large Water Heaters and Small Boilers*. South Coast Air Quality Management District, September 2005.

SCAQMD, 2007. *Addendum to the Proposed Modifications to the Draft 2007 Air Quality Management Plan, Appendices*, South Coast Air Quality Management District, May 2007.

SCAQMD, 2008. *Amended Rule 1110.2 - Emissions from Gaseous- and Liquid- Fueled Engines*, South Coast Air Quality Management District, January 2008

Bell R. P.E., Buckingham F, Ph.D., P.E., *An Overview of Technologies for Reduction of Nitrous Oxides Emissions*, MPR Engineering Services, MPR Profile, Issue 9, Spring 2003

Webster Timothy, John Zink Company LLC, TODD Combustion Group, *Burner Technology for Single Digit NOx Emissions in Boiler Applications*, John Zink Company LLC, March 2001.

Lifshits Vladimir, Coen Company, Inc., *Development of a High Performance Versatile Low NOx Burner*, Coen Company, Inc., January 2002