BOARD MEETING DATE: January 10, 2014 AGENDA NO. 12

PROPOSAL: Rule 1111 Technology Assessment for Residential Furnaces

SYNOPSIS: The November 2009 amendment of Rule 1111 – Reductions of NOx Emissions from Natural-Gas-Fired, Fan-Type Central Furnaces requires staff to report to the Board on the status of technology for achieving the rule's new lower emission limit. Staff provided a preliminary technology assessment at the March 1, 2013 Board meeting. Staff is providing a final technology assessment, a summary of four demonstration projects, and a recommendation to implement Rule 1111.

COMMITTEE: Stationary Source, November 15, 2013; Reviewed

RECOMMENDED ACTION:
Receive and file.

Barry R. Wallerstein, D. Env.
Executive Officer

EC:LT:JC:GQ:WB/BC/AB

Background

The purpose of Rule 1111 – NOx Emissions from Natural-Gas-Fired, Fan-Type Central Furnaces (Rule 1111) is to reduce emissions of nitrogen oxides (NOx) from gas-fired, fan-type residential space heating furnaces with heat input ratings between 50,000 and 175,000 British thermal units per hour (Btu/hr). The rule applies to manufacturers, distributors, sales outlets and installers of such furnaces. The rule also requires manufacturers to certify that each furnace model offered for sale in the SCAQMD complies with the emission limit. The rule requires emissions testing using specific test methods approved by the SCAQMD and U.S. EPA. Most single family homes, many multi-unit residences and some small commercial buildings in the SCAQMD use this type of space heating equipment.

Rule 1111 was adopted by the SCAQMD Board in December 1978 and at adoption addressed all sizes of space heating furnaces. The original rule required all residential and commercial space heating furnaces to meet a NOx emission limit of 40 nanograms per Joule (ng/J) of heat output (equivalent to 55 ppm at a reference level of 3% oxygen) beginning January 1, 1984. At the December 1978 rule adoption Hearing, a rule requirement that all space heating furnaces meet a 12 ng/J NOx emission limit by 1995 was considered by the Board but not adopted.

Rule 1111 was amended in July 1983 in order to limit applicability to units sized for residences and exempted larger commercial space heaters. The rule amendment limited applicability to furnaces with a heat input of less than 175,000 Btu per hour, or for combination heating and cooling units, a cooling rate of less than 65,000 Btu per hour. The July 1983 amendment also exempted units manufactured for use in mobile homes (manufactured housing), revised the definition of efficiency, and clarified testing procedures.

Technology Forcing Limits

In November 2009, Rule 1111 was amended by the SCAQMD Board consistent with the objectives of Control Measure CMB-03 of the 2007 Air Quality Management Plan (AQMP). The 2009 amendment established a new lower NOx emission limit of 14 ng/J (20 ppm at reference level of 3% oxygen) for residential furnaces, which reflects a 65% reduction from the then current limit of 40 ng/J (55 ppm). At the time Rule 1111 was amended in 2009, there were no commercially available units meeting the future effective limits.

Implementation of lower NOx emission limits from the November 2009 rule amendment began in 2012. New mobile home heating units, which were unregulated prior to the 2009 amendment, had to meet a NOx limit of 40 ng/J in 2012 with a future limit of 14 ng/J in 2018. The 40 ng/J emission limit for mobile home furnaces was based on burner and control technology used in existing residential furnaces.

All other new residential space heating furnaces must meet a 14 ng/J NOx limit by October 1, 2016. The 2009 amendment requires the three major categories of residential furnaces – condensing (high efficiency), non-condensing and weatherized – to meet the new 14 ng/J NOx limit by 2014, 2015 and 2016 respectively.

The 2009 amendment to Rule 1111 also made a number of other changes to the rule including updating references to test methods for determining compliance with rule emission limits and providing more specificity in the labeling requirements. To facilitate the depletion of existing inventories and to ensure smooth transition to the new limits, Rule 1111 also provides a temporary 10-month exemption (a sell-through period)

for units manufactured before the applicable future compliance date and delivered into the SCAQMD prior to the compliance date.

Technology Development and Early Compliance Incentives

As indicated above, at the time Rule 1111 was amended in 2009, there were no commercially available units meeting the future effective limits. In order to encourage and accelerate technology development, Rule 1111 provides an incentive for early compliance with the 14 ng/Joule NOx emission limit. Companies that deliver 14 ng/J furnaces into the SCAQMD prior to the applicable compliance date can elect to receive a payment of $75 for each standard efficiency furnace and $90 for each high-efficiency unit sold and delivered into the SCAQMD 90 days prior to the applicable compliance date. These manufacturer rebates will result in savings of $150 to $350 to consumers because of cost markups in the supply chain. This early compliance program is funded by the SCAQMD Rule 1121 Mitigation Program and provides up to $3,000,000 for the residential furnace rebate program. Rule 1121 regulates gas-fired water heaters. As funds are limited, payments for early compliance are on a first-come, first-served basis. To promote and assist the development of compliant furnaces, the resolution for the 2009 rule amendment also committed SCAQMD funding for residential furnace technology demonstration projects.

Technology Assessment and Other Commitments

The 2009 amendment of Rule 1111 also requires a technology assessment and status report to the Board. This technology assessment evaluates both the feasibility of the new lower NOx emission limit and the rule implementation schedule. In addition, the amending resolution requires SCAQMD staff to include an analysis of a mitigation fee option that would allow manufacturers to delay compliance with the new NOx limit.

Basis for the 14 ng/J NOx Limit

The choice of the 14 ng/J NOx limit was based on many factors. The first is that a 12 ng/J emission limit was deemed feasible by staff and proposed to the Board at rule adoption in 1978. Second, the burner technology will be the same for any emission limit between 10 and 20 ng/J (15 to 30 ppm). Third, while emissions of 10 ng/J (15 ppm) have been achieved in practice by residential tank-type water heaters regulated by SCAQMD Rule 1121, a higher limit for residential heating furnaces is more appropriate because of the higher heat output per square inch of burner surface anticipated. In addition, in the 2006 rule amendment analysis for SCAQMD Rule 1146.2 that regulates small boilers and large water heaters with a similar heat output, 14 ng/J was determined to be the most cost effective NOx emission limit when reducing emissions from a limit of 40 ng/J.

The lower emission limit put in place by the 2009 rule amendment will require manufacturers to develop new burners and other compatible technology. To achieve

NOx emission levels of 14 ng/J (20 ppm), space heating furnaces will need to be outfitted with premix burners. Premixing of fuel and combustion air allows finer control of combustion and reduces emissions of NOx, unburned hydrocarbons (VOCs) and carbon monoxide. Premixing also allows spreading the burner flame over a larger area which reduces peak flame temperature and NOx. In addition, modern residential space heating furnaces require the use of exhaust fans. The negative pressure produced by the exhaust fan in the heat exchanger and combustion zone can assist in the mixing of fuel and air prior to and during combustion.

Demonstration Projects and Technology Assessment

Immediately after Rule 1111 was amended in November 2009, the SCAQMD Technology Advancement Office (TAO) initiated a Request for Proposals (RFP) to develop prototype residential furnaces that meet the new 14 ng/J NOx limit in Rule 1111. A request for proposals was issued in February 2010 and TAO staff selected four bids for funding, including two furnace manufacturers, one burner manufacturer and a research institute familiar with residential furnaces. The total cost of the four projects was $1,447,737 with $447,737 provided by The Gas Company and $50,000 provided by the San Joaquin Valley Unified Air Pollution Control District.

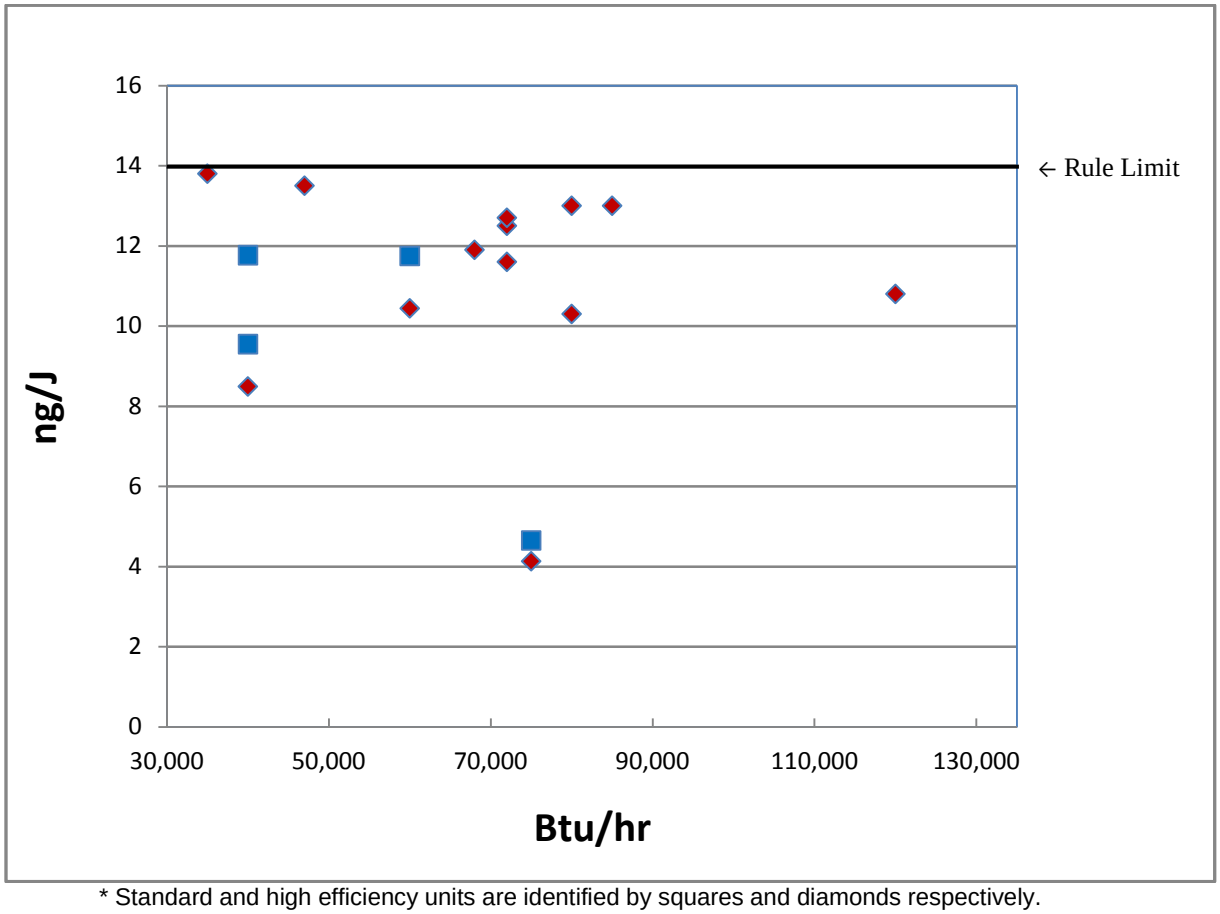
The four proposals were approved by the SCAQMD Board at the June 2010 meeting. The four projects demonstrate multiple furnace types (i.e., standard efficiency, high efficiency, a range of heat outputs and variable firing rates versus on-off operation). The selected projects are summarized in Table 1 below.

Table 1 – Rule 1111 Technology Demonstration Projects

Project	Award Amount	Scope
Beckett Gas	$379,386	Two furnaces: one condensing and one non-condensing
GTI	$450,000	One furnace each for five manufacturers: Carrier, Johnson Controls, Lennox, Rheem and Thermo Products
Ingersoll Rand	$368,261	Two furnaces: each two-stage condensing furnaces with one average and one higher heat output
Nordyne	$250,090	Three furnaces with different firing rates: one single-stage (on/off), one two-stage (high/low/off), and one modulating (low to high and off)

The results of the four technology demonstration projects (Figure 1) indicate that the 14 ng/J emission limit in Rule 1111 is achievable in both standard and high efficiency furnaces (condensing furnaces) with single or variable firing rates. Essentially, all prototype furnaces developed by the contractors achieved the project objectives of meeting the NOx emissions limit of Rule 1111 and passed initial safety tests, except for one furnace. This furnace, while it met the Rule 1111 emission limits, is yet to complete its safety testing. In addition, another contractor has requested additional time through March of 2014 for the completion of the safety testing and submittal of the final report. This contractor has developed two prototype furnaces.

Figure 1 – Prototype Furnace NOx Emissions (ng/J) *



* Standard and high efficiency units are identified by squares and diamonds respectively.

The prototype furnaces developed through these four projects demonstrate that the new lower Rule 1111 NOx limit is achievable in all of the types of forced air residential heating furnaces produced for the United States market. In addition, testing indicates that furnaces with the new burners developed for the projects can also meet industry safety requirements. Now that prototype furnaces have been developed, the next steps for each manufacturer would be to complete the product design and select materials of

construction, combustion controls and manufacture of the new units. Staff also expects that the technology developed for these residential furnaces will be applicable to commercial-sized furnaces that were included in the 2012 AQMP. Smaller commercial forced air furnaces use the same basic design as residential furnaces.

Discussions with Stakeholders and Staff Recommendations

Staff has met with industry representatives to summarize the status of the technology demonstration projects and discuss rule implementation. The Rule 1111 Task Force met on November 7, 2013 with representatives from manufacturers, the industry association and other stakeholders. Staff has also held individual meetings with several of the manufacturers. While some stakeholders indicated their readiness to introduce compliant products into the market on or before the effective dates of the rule, some others indicated their need for additional time to develop new products that will meet the lower NOx limit. The industry association has requested that rule compliance dates, especially the October 1, 2014 date applicable to high efficiency condensing units, be delayed somewhat and the rule be amended to include a mitigation fee option.

Because of delays in completing the residential furnace demonstration projects and to respond to industry's request for more time, staff is inclined to propose an amendment to Rule 1111. As part of that amendment, staff will consider inclusion of a mitigation fee option in the rule but wishes to continue discussion with stakeholders on the issue of delaying compliance dates. Staff commits to:

- Continue Rule 1111 Task Force meetings to discuss emission limit compliance dates with stakeholders;

- Initiate rule development for an amendment to Rule 1111 which will include an appropriate mitigation fee option that does not adversely impact manufacturers that have already developed compliant products; and

- Submit a Rule 1111 amendment to the Board prior to the October 2014 meeting.